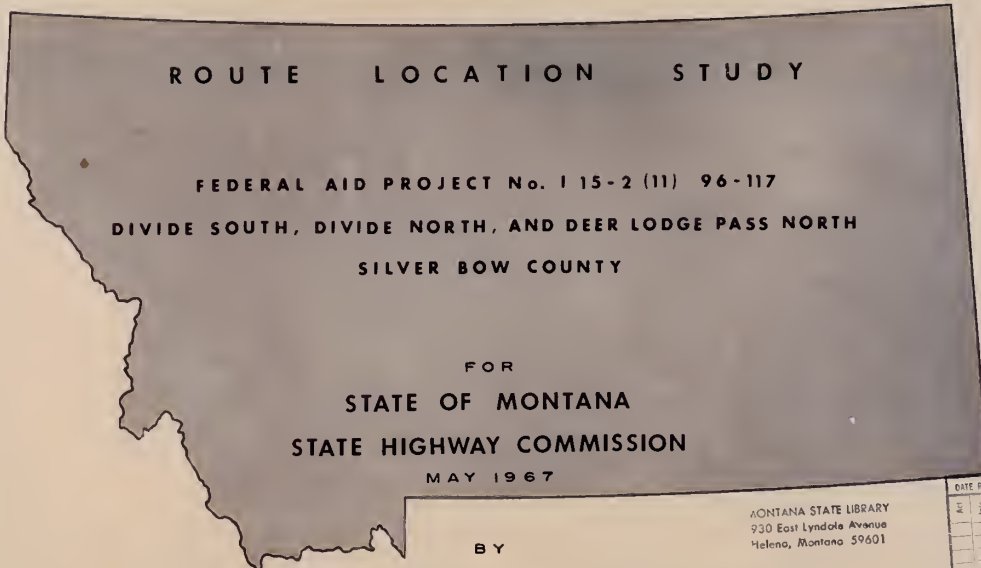
INTERSTATE HIGHWAY 15



ROUTE LOCATION STUDY

FEDERAL AID PROJECT No. I 15-2 (11) 96-117

DIVIDE SOUTH, DIVIDE NORTH, AND DEER LODGE PASS NORTH

SILVER BOW COUNTY

FOR

STATE OF MONTANA

STATE HIGHWAY COMMISSION

MAY 1967

BY

RADER AND ASSOCIATES

ENGINEERS AND ARCHITECTS

MIAMI, FLORIDA HELENA, MONTANA

JOB NO. 5654

MAP OF SOUTHWEST MONTANA

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May 18, 1967

Montana Highway Commission
Helena, Montana

Gentlemen:

In accordance with the terms of our agreement dated March 21, 1966, we are pleased to submit herewith our engineering report for the Route Location Study of Federal Aid Interstate 15 from Melrose to Butte, in Silver Bow County. This report is intended to serve as a basis for final design of the project.

Alignment studies for numerous routes between the project termini were made on aerial topographic mapping supplied by the Montana Highway Commission. Two basic lines, totaling 42.5 miles, were selected for inclusion in the location study. The preliminary plans, profiles, construction details, and cost estimates for all alternates have been separately reviewed with your Department. This report, containing the pertinent test, tables and exhibits, outlines the reasons for our recommendations regarding the best routing through the study area.

We wish to take this opportunity to express our appreciation to the members of the Montana Highway Department and the Bureau of Public Roads for their continual cooperation and valuable assistance during the course of this Route Location Study.

Very truly yours,

RADER AND ASSOCIATES

By: Earle M. Rader

Earle M. Rader

EMR:KA:blg

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INTRODUCTION

This report involves a route location study for approximately 21 miles of Interstate Highway 15 in Silver Bow County, Montana, covered by your Project No. I 15-2(11)96-117, beginning at a point approximately 3 miles north of Melrose and ending at a point approximately 10.5 miles south of Butte. These termini are shown in Exhibits 2 and 3.

Any route between the above described points, and lying within the designated corridor, as established for this study and furnished to the Consultant by the Montana State Highway Commission, would generally follow the Union Pacific Railway and the existing U.S. 91.

The study was based on detailed topographic maps, at a scale of 1" = 200' and 5 foot contour intervals, and aerial photo data prepared and assembled by the Montana State Highway Commission. A band of interest approximately 1 mile wide was used in the development of the mapping, with the existing highway U.S. 91 being the approximate center of the corridor.

The study area for this section of Interstate 15 lies within a series of interconnected basins and valleys, and the topography varies from sloping gently to hilly in nature, with mountain ranges flanking both the eastern and western sides. The Continental Divide traverses this area, from east to west, at a point approximately 4 miles south of the northern terminus. Generally, the runoff from the northern slopes of the divide flows northerly through this area into Sand Creek; while that portion on the southern slopes drains into Divide Creek and Moose Creek, and continues to flow into the Big Hole River. The entire area is dissected by many small creeks and gulches as well as irrigation ditches.

The selection of the alternate routes studied was influenced by the terrain of the area. Careful consideration was given to the type of access facilities to be provided for the irrigated and grazing lands traversed by this project.

During the preliminary studies various alignments, and combinations thereof, were considered. Subsequent to a field review held on September 15, 1966, by members of the Montana State Highway Commission, the Bureau of Public Roads and the Consultant, two basic lines, totaling 42.5 miles, were selected and agreed upon for inclusion in the location study. Exhibits 2 and 3 show the general location plan of these alternates, designated as the "Hill Route" and the "Valley Route", together with their various connection roads, interchanges, frontage roads, crossroads and vehicular underpasses. The location of both alternate alignments was controlled by natural passes, the Union Pacific Railway, the existing highway U.S. 91, and the necessity of controlled access facilities throughout the project area.

The following is a brief outline of the different phases which were studied in detail in order to arrive at the recommended route alternates:

1. Design Standards and Criteria - Design standards were developed from Montana Highway Commission Standards and AASHO policies.

2. Geometrics and Location - A complete study of horizontal and vertical alignment for many possible routes was made.

3. Hydraulics and Drainage - A complete study of drainage areas, runoffs, and stream relocations was made to determine the size of drainage structures required.

4. Soils and Geology - A geological study was made of the area by use of air photos and field reconnaissance.

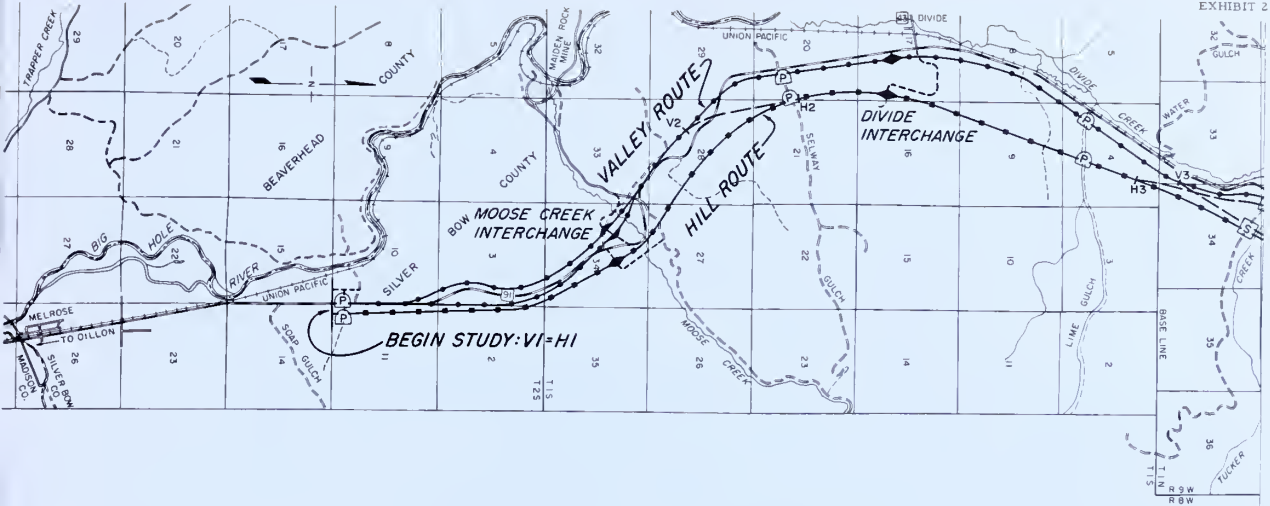
5. Interchanges - Recommendations are made for interchange types and general locations.

6. Bridges and Major Structures - Recommendations are made for type, length and location of required bridges and major drainage structures.

7. Access Facilities - Recommendations for frontage roads to serve abutting property owners are made in this report as well as vehicular underpasses.

8. Traffic and Economic Analysis - A road user benefit analysis was made for each route for the purposes of determining and justifying the recommended route. The results are reported herein.

9. Construction Cost Estimate - Comparable cost estimates for all route alternates and all phases of construction are tabulated.



MATCH LINE
SEE EXHIBIT 3

LOCATION PLAN OF ALTERNATES STUDIED

INTERSTATE 15 DIVIDE NORTH & SOUTH

LEGEND

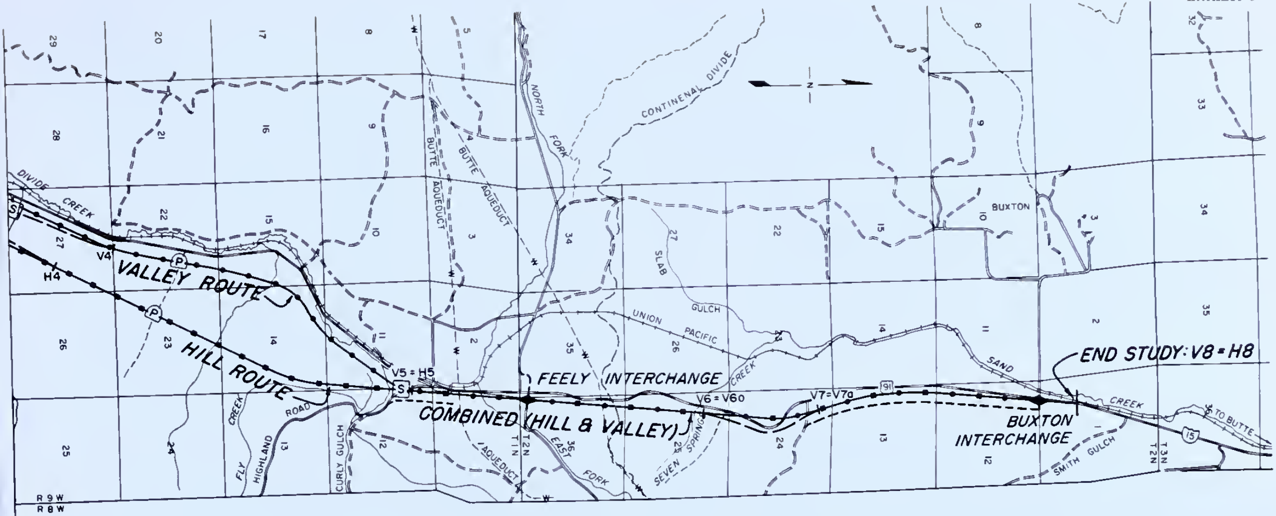
INTERSTATE		EXISTING
HILL ALTERNATE		U.S. HIGHWAY 91
VALLEY ALTERNATE		LOCAL ROADS
COMMON ALIGNMENT (HILL & VALLEY)		U.P. RAILROAD
ALTERNATE CONNECTIONS		CREEKS
FRONTAGE ROADS, X-ROADS		TRAILS
JUNCTION DESIGNATION	V1 H1	

S MAJOR VEHICULAR UNDERPASS STRUCTURE

P VEHICULAR UNDERPASS STR. PLATE PIPE STR.

GRAPHIC SCALE
1 1/2 0 1 MILE

RADER AND ASSOCIATES
Engineers and Architects
Miami, Florida - Helena, Montana



LOCATION PLAN OF ALTERNATES STUDIED

INTERSTATE 15 DIVIDE NORTH & SOUTH

LEGEND

INTERSTATE

- HILL ALTERNATE
- VALLEY ALTERNATE
- COMMON ALIGNMENT (HILL & VALLEY)
- ALTERNATE CONNECTIONS
- FRONTAGE ROADS, X-ROADS
- JUNCTION DESIGNATION V1 H1

EXISTING

- U.S. HIGHWAY 91
- LOCAL ROADS
- U.P. RAILROAD
- CREEKS
- TRAILS

S MAJOR VEHICULAR UNDERPASS STRUCTURE

P VEHICULAR UNDERPASS STR PLATE PIPE STR

GRAPHIC SCALE

1 1/2 0 1 MILE

RADER AND ASSOCIATES
Engineers and Architects
Miami, Florida - Helena, Montana

SUMMARY AND RECOMMENDATIONS

The purpose of this study was to determine the most desirable and economical routing of Interstate Route 15 between Melrose and Butte, in Silver Bow County, Montana. Exhibits 2 and 3 show the area under consideration and the general location of the various alternate alignments studied.

The design standards used for this study were derived from AASHO and the Montana Highway Department criteria. The horizontal and vertical alignment was established on the basis of design speeds of 70 m.p.h. and 60 m.p.h. for the freeway, depending on the nature of terrain, 45 m.p.h. for all ramps, and 30 m.p.h. for all crossroads and frontage roads. Typical roadway and bridge sections were developed in accordance with the Montana Standards for Interstate projects.

During the initial phase of preliminary line and grade studies, earthwork quantities were considered to be of prime importance in determining the best location and most desirable route alternate. Cross sections, on all lines considered, were taken every 500', and points of maximum cut and fill were determined from the contour mapping. Various profile grade designs for these routes were programmed for an electronic computer, and the most economical earthwork volume and mass haul were determined for each line studied. The profile grades were adjusted in an effort to obtain a balance earthwork for the project.

On the basis of the comparative construction cost estimates for all pertinent items, and the findings of the field review held on September 15, 1966, by members of the Montana Highway Commission, the Bureau of Public Roads and the Consultant, two basic lines were selected for further study and inclusion in the final location report. Detailed construction costs of the various segments of these two routes, and combination thereof, are shown in Table 5.

For convenient reference, these routes are identified in relation to their geographical location as the "Hill" route, which generally follows the eastern bench land, and the "Valley" route, which generally follows the present travelled way (P.T.W.). For identification purposes, the junction points of the various route segments have been designated by a letter - number combination; "H" for Hill route and "V" for Valley route, with number suffixes increasing from south to north.

The 42.5 miles of alternate routing studied herein represents the results of elimination, through cost analysis and field review, of the undesirable possible routes. Several alternate alignments and interchange locations through the Moose Creek area were considered, but none would improve tbe line or grades. The two routes, indicated V_1 - V_2 and H_1 - H_2, were finally chosen for further study.

Ten possible combinations could be made with the southern portions V_1 - V_5 and H_1 - H_5 of the two basic routes and their common line on the northern portion $V_5 = H_5$ to $V_8 = H_8$. Eight of these ten alternate alignments were selected for study to determine the recommended routing of Interstate 15. Table 1 shows the summary of the total initial and annual costs of these alternate alignments.

Of the two alternate routes "F" and "G", on the northern portion of the project, it is recommended that route "G" via Sand Creek connection road (V_5 V_{6a} V_{7a} V_8) be used for the development of contract plans for this section of Interstate 15. The construction cost of this route is approximately $32,000 less than that of "F"; and, furthermore, this alignment would preserve existing U.S. 91 to serve as a detour during construction, and a continuous frontage road from Buxton Interchange to Divide Interchange.

On the basis of geometrics, road user cost, initial cost, annual cost and/or aesthetic evaluations, alternate alignments AG, BG and CG have been deemed most worthy of final consideration for the recommended routing.

Right of way did not become a major factor in the cost analysis until the final route comparisons were made. Generally, a strip 300 foot wide would be required for both alternates, with the exception of the areas of extreme cuts and fills, interchanges, channel changes, independent alignment, frontage roads and rest areas, where wider right of way will be warranted. In many instances, the roadways of the Valley route are adjacent to the P.T.W. right of way, and, consequently, lesser acquisition will be needed.

Proposed access facilities were studied in detail on both routes. Wherever possible, interchanges and frontage roads were provided for access. However, when it became economically unfeasible to provide this type of service, severence damage values were added to the right of way costs. The Montana Highway Commission Right of Way Division prepared an evaluation of the right of costs, depreciation and access facility justifications for both alternate routes, as shown on plan and profile sheets, assuming that access control would be provided throughout the project.

A public hearing regarding the Interstate location for this project was held at Divide on February 16, 1967, at which date the method of local access and alternate route locations were thoroughly discussed, and shown by an exhibit map. It was also carefully explained that the four proposed interchanges would be the only local access points of entrance to the Interstate

via the P.T.W. The concern of most of the people attending the hearing seemed to be that they should have some kind of guarantee of having a permanent cattle drive easement throughout the length of this project. It was explained that numerous bladed trails are anticipated for supplemental local access, but were not shown on the exhibits and the preliminary plan sheets, or discussed in the report. It was also pointed out that where the P.T.W. was disturbed or could not be used for cattle drive, some type of easement will be perpetuated. This matter should be considered and resolved prior to actual right of way acquisition.

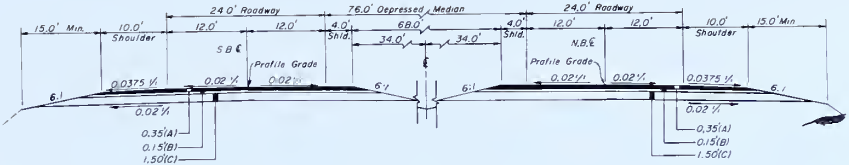
It could be concluded that the majority of the attendees of the public hearing were in favor of the Hill route or combinations thereof; and that no objections were voiced to the number of location of the interchanges. Therefore, no changes were suggested that would influence the recommended route selection as described in this report.

On the basis of the major considerations discussed above and throughout this study, alternate CG, as designated in Table 1, and shown on "Location Plan of Alternates Studied", Exhibits 2 and 3, can now be established as the recommended alignment for this section of Interstate 15. This route, via V_1 V_2 H_2 H_3 H_4 $H_5 = V_5$ V_{6a} V_{7a} V_8, is also shown by a solid line on the detailed plan and profile sheets 1 to 37 inclusive, at the conclusion of this report. As shown in Table 1, the total initial cost of alternate CG, amounting to $8,611,820, is the least of all alignments studied. However, its total annual cost of $2,276,720 is about $34,000 higher than alternate EG which has the least annual cost, and only about $12,000 higher than the total annual cost of alternate AG.

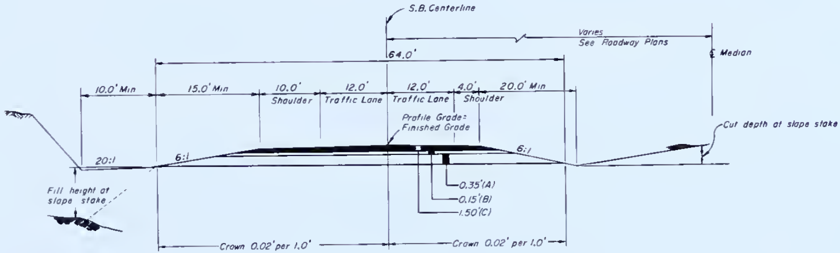
Analysis of the economic and geometric considerations, as listed in Tables 1 and 2, of the three alternates AG, BG and CG selected for final comparison, reveals that there is no appreciable difference in their major evaluated items to strongly recommend one alternate over the others. Nevertheless, as discussed previously, there are a few significant factors weighing in favor of the alternate alignment CG through the major portion of this project, mainly its lower total initial cost, the ease of right of way acquisition, and the absence of detours needed during construction, since it leaves existing U.S. 91 undisturbed to serve both as a detour and a continuous frontage road. However, it should be recognized that, during right of way negotiations, a substantial difference of opinion will be voiced by the farm units, severed by either Valley or Hill routes, as to the land value and the severance damages resulting from the construction of the Interstate.

It is, therefore, recommended that alternate alignment CG, as defined, discussed and detailed herein, complete with its local access features, be selected for the development of contract plans for Interstate Route 15 through this study area.

Early review and consideration of the contents of this route location study, and approval of its findings, by the Montana Highway Commission, will be greatly appreciated in order that scheduling of control surveys and design mapping by aerial photogrammetric methods can be accomplished during late spring 1967.



100' CENTER TO CENTER



INDEPENDENT LINES

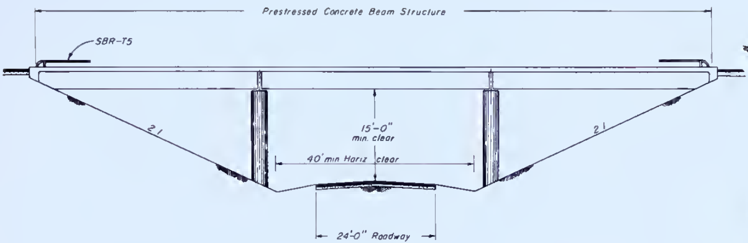
—LEGEND—

A: Compacted Plant Mix Bituminous Surfacing
B: Compacted Crushed Top Surfacing (Leveling Course)
C: Compacted Crushed Base Surfacing

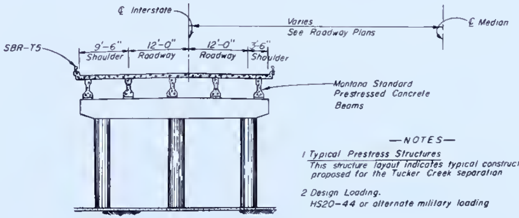
—BACKSLOPES—

Cut or fill depth	0'–5'	5'–10'	10'–15'	Over 15'
Cut Slope	5:1	4:1	3:1	2:1
Fill Slope	6:1	4:1	3:1	2:1

FOUR LANE MAIN ROADWAY SECTIONS



ELEVATION



—NOTES—

1 Typical Prestress Structures
This structure layout indicates typical construction proposed for the Tucker Creek separation

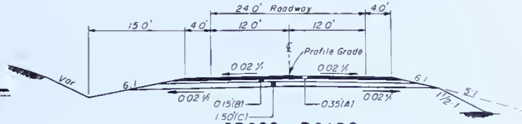
2 Design Loading.
HS20-44 or alternate military loading

SECTION

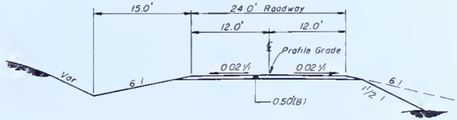
Scale 1/16"= 1'-0"

MAJOR VEHICULAR UNDERPASS

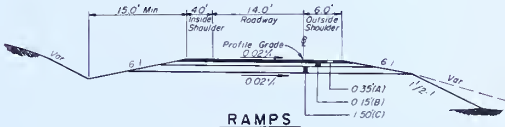
4 LANE DIVIDED HIGHWAY



CROSS ROADS
(PAVED)



CROSS ROADS AND FRONTAGE ROADS
(GRAVEL)



RAMPS

—LEGEND—

A=Compacted Plant Mix Bituminous Surfacing
B=Compacted Crushed Top Surfacing
C=Compacted Crushed Base Surfacing

TYPICAL SECTIONS

TABLE 1

ALTERNATE ALIGNMENT COST SUMMARY

South Portion V_1 to V_5 or H_1 to H_5

A = Hill Route (H_1 H_2 H_3 H_4 H_5)
B = Valley Route (V_1 V_2 V_3 V_4 V_5)
*C = Route Via Connection V_2 - H_2 (V_1 V_2 H_2 H_3 H_4 H_5)
D = Route Via Connection V_3 - H_4 (V_1 V_2 V_3 H_4 H_5)
E = Route Via Connection H_3- V_4 (H_1 H_2 H_3 V_4 V_5)

North Portion H_5 = V_5 to V_8 = H_8

F = Common Route North Portion (V_5 V_6 V_7 V_8)
*G = Route Via Sand Creek Alternate (V_5 V_{6a} V_{7a} V_8)

Alternate Alignment Designation	Total Length in Miles	Total Initial Cost	Total Annual Cost
AG	20.985	$ 8, 712, 310	$ 2, 264, 940
BG	21.627	9, 105, 860	2, 329, 360
*CG	21.047	8, 611, 820	2, 276, 720
DG	21.493	9, 326, 780	2, 347, 520
EG	21.136	8, 717, 380	2, 242, 760
AF	20.951	8, 743, 880	2, 262, 640
BF	21.592	9, 137, 440	2, 327, 080
CF	21.013	8, 643, 392	2, 274, 440

Note:

1. The total initial cost is the initial project construction costs including Right-of-Way and related items.
2. The total annual cost is the sum of the annual costs for construction maintenance and vehicle operation.

* Recommended Route

DESIGN STANDARDS

The following design criteria, developed for this study, has been derived from the "Geometric Design Standards for the National System of Interstate and Defense Highways," which were approved by the American Association of State Highway Officials (AASHO) and the Bureau of Public Roads, and adopted by the States. The following books and publications were also used as guides for all required design features.

<u>Geometric Design Standards for Highways other than Freeways</u> - AASHO
<u>Highway Capacity Manual</u> - Highway Research Board 1965
<u>Policy on Geometric Design of Rural Highways</u> - AASHO 1965
<u>Road User Benefit Analysis for Highway Improvement</u> - AASHO

<u>Standard Specifications for Road and Bridge Construction</u> - MSHC
<u>Standard Drawings</u> - MSHC
<u>Field and Office Standards</u> - MSHC

Design Speed

Freeway - Rolling Terrain	70 mph
Freeway - Mountainous Terrain	60 mph
Ramps, Minimum	45 mph
Ramps at exit and entrance terminals	50 mph
Crossroads and Frontage Roads, Minimum	30 mph

Maximum Horizontal Curvature

Freeway - Rolling Terrain	3° 30'
Freeway - Mountainous Terrain	5° 00'
Ramps, Maximum	10° 00'
Ramps at exit and entrance terminals	7° 30'
Crossroads	23° 00'
Frontage Roads	25° 00'

Maximum Gradients

Freeway - Rolling Terrain	4%
Freeway - Mountainous Terrain	6%
Ramps, Descending	7%
Ramps, Ascending	6%
Crossroads	6%
Frontage Roads	10%

Minimum Length of Vertical Curves

Freeway	800'
Ramps	200'
Crossroads	200'
Frontage Roads	200'

Minimum Vertical Clearances

Local Road under Interstate Facility	15'-0"
Interstate Highway Under	17'-0"
Channel under Structures	3'-0" minimum clearance over high water

Spiral Lengths

	D_c	L_s
Freeway curvature	0° to 1° 15'	none required
	1° 30'	150'
	1° 30' to 5° 00'	Varies* (500' max.)
	5° 00'	500'

*(use minimum transition Length $L_s = 100\ D_c$)

Ramps, Frontage Roads, & Crossroads	none required

Superelevation

Maximum rate = 0.08 ft./ft.

Design Vehicle

The WB 50 design vehicle shall govern all intersection designs.

Roadway Design

The pavement sections used for this study, four lane facility, are shown on Exhibit 4 entitled "Four Lane Main Roadway Section."

Structural Typical Section

See Exhibit 5

Structure Loading

Interstate Highway Structures: H20-S16 modified for military vehicles.

Other Highway Structure: H20-S16.

All four lane divided roadway sections have been designed for 600 foot stopping sight distance as specified by AASHO, thus maintaining a 70 mph design speed throughout the length of this Interstate facility; although some steep gradients would dictate only a 60 mph or less design capacity speed, since it was impossible to maintain longitudinal gradients of 4% or less, as required for 70 mph design criteria.

In studying the location of the four lane Interstate facility, relative to the P.T.W. and other physical features and conditions, it has been determined that the distance between northbound and southbound traffic lanes will be 100 feet center to center, except in the areas where independent alignments were used.

TABLE 2

GEOMETRIC SUMMARY

Route Alternate Designation	Length Miles	Average Grade %	Maximum Grade %	Percent of Curvature	Average Degree Curvature	Maximum Degree Curvature	Total Horizontal Deflection
South Portion Project							
A (Hill Route H_1 H_2 H_3 H_4 H_5)	14.178	2.463%	+5.042%	19.06%	1° - 00'	1° - 30'	152° - 00'
B (Valley Route V_1 V_2 V_3 V_4 V_5)	14.820	2.362%	+5.000%	40.36%	1° - 00'	3° - 00'	332° - 30'
*C (Route Via Conn. V_2 H_2)	14.240	2.592%	+5.000%	21.37%	1° - 10'	2° - 00'	158° - 00'
D (Route Via Conn. V_3 H_4)	14.686	3.028%	+5.000%	28.04%	1° - 10'	3° - 00'	211° - 00'
E (Route Via Conn. H_3 V_4)	14.330	1.899%	+5.042%	29.16%	1° - 00'	1° - 30'	233° - 30'
North Portion Project							
F (Common Route V_5 V_6 V_7 V_8)	6.773	1.833%	+4.000%	29.28%	1° - 08'	2° - 00'	95° - 00'
*G (Route Via Sand Ck. Alt. V_5 V_{6a} V_{7a} V_8)	6.807	1.834%	+4.000%	33.49%	1° - 12'	2° - 00'	120° - 45'

From the above comparisons of the geometry of the various route alternates, it can be concluded that the Hill Route, or combinations thereof, would be somewhat better than the Valley Route with respect to horizontal alignment. However, the tabulation indicates that the Valley Route would have flatter grades.

*Recommended Route.

DESCRIPTION OF ROUTES STUDIED

On the basis of the aerial photography, the developed mapping, and field reconnaissance of the area, numerous routes, and combinations thereof, were considered during the preliminary stages of this location study.

Detailed analysis of each of the proposed lines revealed that the studied route alternates were generally similar in topographical and geological aspects, and equally comparable from the point of view of total initial cost and total annual costs. Consequently, evaluation of the right of way costs of the various alignments considered, and access facility justifications, were the prime deciding factors in the selection of the alternate routes found to be worthy of further study.

All alternate routes considered, and presented herein, lie easterly of the existing highway U. S. 91 and the Union Pacific Railway. It was determined that any possible line location westerly of U. S. 91, within the subject valley, would entail numerous structures overpassing the railroad, and would not result in a balance earthwork design. Furthermore, Sand and Divide Creeks, meandering throughout the western area of U. S. 91, would make channel changes and stream crossings innumerable.

The extent of salvaging the existing highway U. S. 91, and its usefulness as a frontage road and/or a detour during construction, were important deciding factors in the selection of the final route location. It can be noted that the Hill route, H_1 - H_8, utilizes approximately 87% of the P. T. W. as a frontage road; while the Valley route, V_1 - V_8, utilizes only 80%. Similarly, the Hill route could leave 96% of the P. T. W. in continuous use during construction of Interstate 15; while the Valley route would only leave 92% of the facility as undisturbed detour.

The two basic alignments, designated as "Hill" and "Valley" routes, generally shown in Exhibits 2 and 3, have a common northern portion from V_5 = H_5, Valley Route Station 787+30, to the end of the project V_8 = H_8, Station 1147+90. Both basic alternate routes, and the various connection roads, are shown in detail on the plan and profile sheets 1 to 37 inclusive. Rest areas for both alternate routes are shown on plan sheet 29.

Hill Route H_1 - H_8

The Hill route begins at Station 4+40, and parallels existing U. S. 91, approximately 200 feet easterly thereof, to Station 55+00. From this station to the common point V_5 = H_5 of the Hill and Valley routes, this line generally follows the eastern bench land of the P. T. W. As mentioned previously, the southern portion of this route would have the advantage of leaving U. S. 91 intact to serve as a frontage road.

The main features of the Hill route are the following:

1. Length - This is the shortest of all routes studied, with only 20.95 miles between the project termini.
2. Interchanges - There are four interchanges on this route, as indicated in Exhibits 2 and 3.
3. Structures - There are two grade separation structures, five vehicular underpasses, and fifteen major drainage structures on this route, not including the interchange structures.
4. Frontage Roads - Existing U. S. 91 will serve as a frontage road left of the entire route. Frontage road will be needed right of Moose Creek Interchange; left of Buxton Interchange; and at three other locations.
5. Right of Way - Since this route is located mostly on grazing land, right of way acquisition is a minor consideration.
6. Detouring of Traffic during Construction - Since this route is completely separate from the present U. S. 91, detouring of traffic during construction will be no problem, except from Station 955± to Station 980±. However, since the recommended route is via Sand Creek connection road, the need for detouring in this segment is eliminated.

Valley Route V_1 - V_8

The median centerline of the Valley route lies directly over the centerline of the P. T. W., U. S. 91, from beginning Station 4+40 to Station 35+00, where the route diverges from the existing highway and bifurcates, ending the split alignment at Station 207+80. This route is generally parallel to and right of the existing U. S. 91, except for three relatively short segments where it is located left of the P. T. W.

The main features of the Valley route are the following:

1. Length - This route is shorter by less than 200 feet than the longest of all alternates studied, with only 21.59 miles between its termini.
2. Interchanges - There are four interchanges on this route, as indicated in Exhibits 2 and 3.
3. Structures - On this route there are two grade separation structures, six vehicular underpasses, and twenty major drainage structures, not including the interchange structures.
4. Frontage Roads - In addition to the existing U. S. 91, frontage roads will be needed left of Moose Creek and Buxton Interchanges; and at five other locations.
5. Right of Way - The cost of right of way taking and depreciation for this route is more than double that of the Hill route.
6. Detouring of Traffic during Construction - Since this route is generally located adjacent to existing U. S. 91 for a considerable length, and also crosses the P. T. W. at numerous locations, maintaining a reasonable traffic service will be a major consideration.

TRAFFIC AND CAPACITY CONSIDERATIONS

Presently, U.S. 91 carries approximately 800 vehicles per day between the project limits. With the proposed construction of I 15, all of this traffic will be diverted to the Interstate with the exception of those desiring local access in the area. After construction of I 15, U.S. 91 will serve as a local access road to abutting properties. During the preliminary stage of this study, it was determined that traffic interchanges will be provided at locations near Moose Creek, Divide, Feely and Buxton. Relatively low traffic volumes indicate that diamond interchanges would serve adequately at all of these locations.

By a directive from Montana Highway Commission to the Consultant, it was determined that all considerations, studies, and design on this project would be based upon four-lane criteria regardless of the theoretical future capacity requirements. Therefore, the Capacity Studies for this section have been omitted from this report.

The expanded average daily traffic volume (ADT) and daily hourly volume (DHV), along with the other necessary traffic characteristics used for this Interstate Route study, was furnished by the Montana Highway Commission.

$V_1 = H_1$ to V_2 & H_2

Average Daily Traffic 1962	739 vehicles
Average Daily Traffic 1975	1700 vehicles
Average Daily Traffic 1989 (Design year)	2450 vehicles
Commercial Vehicles as % of ADT	10%
Design Year Hourly Volume (1989 DHV)	300 vehicles

V_2 & H_2 to $V_5 = H_5$

Average Daily Traffic 1962	826 vehicles
Average Daily Traffic 1975	1900 vehicles
Average Daily Traffic 1989	2800 vehicles
Commercial Vehicles as % of ADT	9%
Design Year Hourly Volume (1988 DHV)	350 vehicles

$V_5 = H_5$ to $V_8 = H_8$

Average Daily Traffic 1962	800 vehicles
Average Daily Traffic 1975	1850 vehicles
Average Daily Traffic 1990 (Design year)	2750 vehicles
Commercial Vehicles as % of ADT	9%
Design Year Hourly Volume (1990 DHV)	340 vehicles

SOILS AND GEOLOGY

The proposed route lies in the central part of a large, north trending, intermountain valley of moderate relief. Rugged, forested mountain ranges rise on each side of the valley, but the valley is characterized by the intricate network of small stream gullies separated by grassy, rolling, interstream divides. The interstream divides broaden in places to form benchlands which slope downward from the mountains toward the valley center. Major streams and their tributaries have cut down below the general level of the benchlands.

Richards and Pardee (The Melrose Phosphate Field, Mont. USGS Bull 780, 1926) studied the sedimentary and structural history of this valley, but did not map it in detail. No other published work is available which deals with this specific area. However, Tertiary sediments of similar nature are found filling the valleys of major streams in much of western Montana. In general, these Tertiary sediments are similar from one valley to the next. Mainly, they are poorly consolidated complexly interlayered gravel, sand, silt and clay which have washed into basins from adjacent highlands. Nearly all contain some volcanic ash, and bentonite layers. Lava, ignimbrite, or volcanic agglomerate may be found in some places. In addition, many of these Tertiary sediments show evidence of faulting and mild deformation probably resulting from some widespread crustal disturbance in underlying, older rocks.

In the vicinity of the subject project, the Tertiary sediments are typical of those found elsewhere in Western Montana. In general, these sediments are typified by their diversity. Some of the observed rock types have been listed below.

silty clay
volcanic ash
Tuffaceous silt and sand
bentonite
sand and gravel
loess-like silt
sand (well sorted, weakly cohesive)
hard, dense arkosic conglomerate
arkosic sand (cemented and non-cemented)
silty shale

Other types are undoubtedly present, but not exposed. Although these rocks have been commonly referred to as "lake beds", there is evidence of only periodic lacustrine environment. In fact, most of the rocks seem to have been deposited by streams, perhaps in large coalescing alluvial fans at the base of the bordering highlands. Most of the granular phases of these sediments are weakly cemented by lime. Some of the tuffaceous

rocks are tough and resistant, one layer of hard, dense, arkosic conglomerate crops out south of Divide, Montana. Granite and quartzite predominate as the rock varieties found in Tertiary gravels. However, argillite, hornfels and foliated metamorphic rocks are also common. Rock types such as these are typical of bedrock in the adjacent mountains.

Geologic and Physiographic History

In this region, rocks ranging from Precambrian to Tertiary age make up the bedrock geology and unconsolidated alluvium of Pleistocene and Recent age mantles the older rocks. The mountain masses are made up mainly of granitic rocks of the late Cretaceous (or early Tertiary) Boulder Batholith. The batholith has intruded and altered a variety of older layered rocks including Precambrian gneiss and schist and Paleozoic and Mesozoic sedimentary rocks. The Tertiary sediments here were not involved with the intrusions, but are clearly later and derived from erosion of the Boulder Batholith and its associated metasedimentary rocks.

Although this region has had a complex geologic history prior to the Tertiary, this report deals mainly with events of the Tertiary and later. Rocks older than Tertiary are deeply buried in the vicinity of the proposed alignment as shown in Exhibits 6 and 7, pages 18 and 19, which illustrates the areal geology of the alignment corridor.

For the purpose of more clearly describing the geology, we have included a set of block diagrams in Exhibits 8, 9 and 10, pages 20, 21 and 22, showing an idealized portion of the valley and adjacent mountains. In general, the diagrams illustrate the sequential development of a hypothetical area (similar to the vicinity of Divide, Montana) looking northeastward across Divide Creek.

Diagram No. 1 illustrates the valley as it originally formed, sometime in early Tertiary and after the emplacement of the batholith. It seems likely that the valley represents a structural trough modified by erosive action of a major stream and most of the sediments derived from erosion of the surrounding highlands were carried out and away from the valley.

In the middle Tertiary time (Oligocene) the drainage pattern of the valley was somehow altered and sediments began to accumulate in the valley as illustrated by Diagram No. 2. Richards and Pardee (1926) suggest a climate change (from wet to dry) or a more probable crustal warping and deformation as an explanation for the sediment accumulation. Widespread volcanic activity at about this time may also have resulted in some disruption of the drainage. In any event, the exterior drainage of this valley (and in fact most river valleys in Southwest Montana) was obstructed and sediments began to accumulate. Volcanic ash and tuff and some lake beds form a large part of the earliest sediments; later, silt, sand and gravel predominate. As Richards and Pardee (1926) have pointed out "later (sediments) were supplied almost entirely by waste from the adjacent mountains. The increasing coarseness of the later beds indicates higher stream gradients which in turn suggest growing mountains or a sinking valley".

Fossil remains of Oligocene and Miocene mammals, as well as lizards and turtles, have been found in the Tertiary beds of this region (Richards and Pardee, 1926, pp. 14 and 15). Fossil wood is common near Feely siding on the Union Racific Railway and numerous root and limb casts have been noted in several places. Thus, the valley at this time (Diagram No. 2) was a basin in which sediments were accumulating, drainage was mostly interior, lakes were alternately formed and filled, and the variety of Tertiary plants and animals lived.

Sometime in late Tertiary, widespread crustal disturbances resulted in deformation (by bucking and breaking) of the Pre-Tertiary basement rocks. Some of this deformation was transmitted upward into the Tertiary basin sediments and they were broken and tilted by minor folding and by a series of normal, reverse and rotational faults. Diagram No. 3 illustrates the general nature of this deformation, but is not meant to represent any demonstratable structural fabric. Several faults which cut and displace the Tertiary sediments can be seen in road cuts between Moose Creek and Divide, Montana. For ease of illustration, the deformation is shown as happening all at one time. It is more likely that it occurred over a long period of time and in stages or pulses. In any case, the end result is pictured in the next Diagram (No. 4), which shows a very late Tertiary erosional and depositional surface developed on older, tilted Tertiary sediments. The youngest Tertiary rocks were formed from erosion of the newly uplifted mountains and the tilted blocks of valley sediments. The angular unconformity resulting from this deformation and subsequent erosion is not commonly seen in the area. It was noted once in preliminary field mapping, in a gulley near the east boundary of NW 1/4 NW 1/4, Sec. 28, T. IS., R 9 W., about 1-1/2 miles southeast of Divide. The rocks above the hiatus are nearly horizontal; those below are tilted about 35^{o}, both are nearly identical silty sand and gravel.

With the beginning of the Pleistocene (Ice Age) most stream erosion and deposition decreased. There is ample evidence of alpine glaciation in the higher mountains of this region, but there is no evidence of active glaciation during this time in the central part of the valley itself. However, toward the end of the Pleistocene (and probably during interglacial epochs) a considerable quantity of material poured out into the valley as the glaciers melted in the higher mountains (see Diagram No. 5). The

streams issuing from the mountains were overloaded with glacial debris. Deep alluvial fans were formed at the base of the mountains where the streams gradient abrubtly decreased. In front of the fans an outwash plain developed as numerous meandering streams planed off the underlying Tertiary rocks and covered them with a thin veneer of silty glacial debris. A few blocks of Tertiary rocks were relative topographic "highs" and not covered by Pleistocene outwash. Exterior drainage of the valley was re-established sometime during the Pleistocene.

The glacial debris differs from underlying Tertiary sediments in several ways. The Pleistocene sediments are totally unconsolidated, poorly sorted, very silty gravels. Rock fragments are predominately subangular to rounded and many larger pieces (as large as 3 x 5 feet) show glacial striae and polishing. Tertiary gravels are well sorted, rounded and more or less cemented. The color tone of the Pleistocene sediments is darker than that of the Tertiary both in air photos and in the field. In addition, the nearly horizontal Pleistocene sediments (in most places) lay unconformably upon tilted Tertiary rocks. In some places, they may cover nearly horizontal, late Tertiary sediments.

Diagram No. 6 shows the present topography and its relation to the Tertiary and Pleistocene geology. Much of the existing topography has been developed in late Pleistocene and recent times. The major trunk streams, such as Divide Creek, have cut down through the early Pleistocene surface and into the Tertiary sediments. More recent floodplain deposits and alluvial fans cover the valleys of some major streams. A difference in recent drainage history between the valley area north of the Continental Divide and the valley area south of the divide has been noted in air photo study. Alluvial fans have developed at the mouth and lower reaches of streams and gullies in the "southern" area where the major trunk streams are Divide Creek and Moose Creek. But, in the "northern" area, where the principal stream is Sand Creek; no alluvial fans have developed. Field examination indicates that the fans in the Moose Creek and Divide Creek Drainage systems are being moderately dissected by present streams and are composed of material derived from erosion of Pleistocene glacial deposits and Tertiary sediments. The fans are rich in gravel and are commonly the site of borrow pits in the region. Other than this difference, the general geology of the two separate drainage systems (as shown in the block diagrams) is the same. In both drainage systems, Tertiary rocks crop out on steeper slopes and in gullies and canyons. The early Pleistocene deposits are partly removed and dissected by stream erosion, but are preserved on flat or gently sloping interstream divides. Areas of boulder strewn, hummocky uplands extending out from the mountain front mark the site of deep Pleistocene outwash fans, now partly dissected by stream erosion.

Analysis of Alternate Routes

Two principal routes have been studied for the proposed roadway. One of these has been designated as the Hill or H route because it crosses a system of rolling upland divides and gullies the other has been called Valley or V route because it more or less follows the lowlands adjacent to principal trunk streams. At a point about 6-1/2 miles south of the project terminus the H and V routes coincide to a common Valley route. There are in addition, several minor connecting alternates between the Hill and Valley routes. For the purpose of this report; however, the soil and geologic conditions for only the major lines will be considered with emphasis on kinds of materials expected, anticipated problem areas and backslope design. In most places, soils and geologic conditions from one route will not vary greatly from the other. The conditions expected along the alternate connection roads will be the same as those described for the major routes in the vicinity of the connection.

Hill Route

This route begins (at Station 4+40) on the lower edge of a gently sloping alluvial fan. Alluvium in the fan is mostly silt and gravel. From here the line ascends the fan and enters a system of low hills and gullies at about Station 30. From Station 30 to 157 the alignment will cross a broad, gently inclined stream dissected benchland. Stream gullies here are irregularly spaced along the route and differ greatly in size; the larger ones are partly filled with stream silts and gravels. The benchlands between streams are gravel veneered erosion surfaces developed on tilted Tertiary sediments. The Tertiary bedrock in this interval (from Station 30 to 157) has more clay rich phases than anywhere else on the project. Bentonitic shales crop out in several isolated patches and may be encountered in some road cuts. Close interval borings in cut sections, to depths well below profile grade, will be in order so that all bentonitic layers in the underlying Tertiary rocks will be delineated. Backslopes will be cut mainly into tertiary strata (weekly cohesive clastic sediments) therefore slopes in deeper cuts are expected to be not steeper than 1-1/2:1.

From Station 157 to Station 175 the roadway will be on fill crossing the Valley of Moose Creek. This valley is partly filled with stream deposits (mainly silty gravel) derived from bordering highlands and no foundation problems are anticipated.

From Station 175 to Station 280 the alignment will ascend out of Moose Creek Valley and cross an area of rolling hilly, topography cut by a network of small gullies and arroyos. From Station 280 to Station 530 the interstream areas broaden into nearly flat gently inclined benchlands cut by widely separated, steep walled ravines. Direction of stream flow in this area, as elsewhere on the Hill route, is from right to left.

Deeper cuts in the interval from Station 175 to Station 530 will be in clastic sediments of Tertiary age since weakly cemented Tertiary sands, gravels and tuffaceous rocks predominate in this area. The bentonitic shale and clay rich phases found near the beginning of the project seem to decrease and become rare past Station 200. However, soil and sub-soil investigation in this interval should be carried to a point well below profile grade in order to determine, with certainity, the foundation environment of the roadway. In areas between streams, a variable thickness of silty gravel is expected to be found mantling the Tertiary rocks, but on the flanks of ravines the Tertiary rocks will crop out. Some easily erodable silt may be found as stream alluvium in the bottom of ravines and gullies. Removal of such alluvium should be considered if subsequent soils studies indicate that it is compressible or subject to loss of shear strength when saturated.

Backslopes in deeper cuts from Station 175 to Station 530 are not expected to be steeper than 1-1/2:1. In general, soils conditions are expected to be good.

From Station 530 to Station 535 the roadway will be on fill crossing the broad, shallow valley of Tucker Creek. Further soils investigation should be made in the flood plain of Tucker Creek to determine the depth of the water table and soil and subsoil conditions.

From Station 535 to Station 753+35 the Hill route crosses a system of steep walled ravines separated by broad sloping interstream divides. This terrain is very similar geologically and topographically to that discussed in the interval from Station 175 to Station 530 and the information in that section applies here as well.

One possible problem area was noted in field study near the vicinity of Station 605 to Station 620. Left of centerline in this interval is an area of intense spring activity. Soil boring and testing in this area should be directed at determining the details of ground water and subsurface geology.

From Station 740 to Station 745 the line descends into and crosses the valley of Curly Gulch. At Station 753+00 the Hill and Valley routes become coincident and continue to the end of the subject project.

Valley Route

Beginning at Station 4+40 the alignment ascends the gentle slope of an alluvial fan and is coincident with the alignment of existing U.S. 91 to Station 35. At Station 35 the proposed Valley alignment bifurcates into widely separated lanes which coincide again at Station 165.

The northbound lane is nearly coincident with the Hill route from Station 35 to Station 110. In this interval it will cross a gently sloping benchland cut by numerous gullies and arroyos. Here, as in most of the project, the benchlands are a gravel veneered erosion surface developed on tilted and faulted tertiary strata.

The southbound lane is nearly coincident with existing U.S. 91 from Station 35 to Station 110 and follows close to the bottom of a fairly large ravine, which is the main trunk stream for this area.

Both the northbound and the southbound lanes cross a small divide at Station 110 and then descend toward the valley of Moose Creek. The lanes are separated by a deep gully (a minor tributary to Moose Creek) from Station 110 to Station 153 where they enter upon the valley floor of Moose Creek and converge at Station 165. The valley here is partly filled with silt, sand and gravel derived from erosion of the surrounding highlands. After convergence, the alignment crosses Moose Creek Valley and climbs to higher elevations. The line begins its ascent at Station 170 and follows the east side of a deep ravine; it crosses a summit divide at Station 210 and descends following the course of another ravine towards the valley floor of the Big Hole River. From Station 170 to Station 270 the roadway crosses a highland terrain underlain by Tertiary clastic sedimentary rocks. In this interval, sand and gravel are the predominant constituents of the Tertiary strata although there are some discontinuous clay rich phases. Numerous high angle faults which cut and displace the Tertiary strata can be observed in existing road cuts on U.S. 91 from Station 180 to Station 240. Hot spring mineralization is common in these faults but there are no indications of recent spring activity.

Cut slopes in the interval from Station 170 to Station 270 are expected to be not steeper than 1-1/2:1 and no particular problems related to soils or geology are anticipated. However, drainage considerations will be complicated by the numerous arroyo and gully crossings in this area.

Geology and soils conditions on the Valley route will not be significantly different from the Hill route in the interval from Station 4+40 to Station 270.

From Station 270 to Station 530 the roadway will be nearly parallel to, and distant from approximately 100' to 300' right of existing U.S. 91. From Station 270 to Station 283 the alignment crosses an alluvial fan (of silty gravel) developed at the mouth of Selway Gulch.

At Station 283 a right side cut will be encountered in a thick section of coarse sandy conglomerate. These rock are unlike most Tertiary sedi-

ments in this region in that they enclose a layer (estimated 40' thick) which is lime cemented and very hard and dense. During construction, it is expected that some of this material will have to be blasted. Furthermore, cut slope design will be a problem, in the interval from Station 283 to Station 300, because the cut will be mainly in colluvial debris rather than in-place bedrock. This colluvium is composed principally of silt, sand and gravel derived from erosion of the weakly cemented Tertiary strata, but is also contains many randomly arranged, large masses of the hard layer (some of which have volumes of several hundred cubic feet) as well as a considerable quantity of cobble to large boulder size blocks. Close inspection of this cut, and some test borings are recommended in order to determine the most stable design. It may be necesary to remove most of the colluvial rubble in this interval.

From Station 300 to Station 342 the roadway will be on fill, crossing a portion of the broad, flat flood plain developed at the junction of Divide Creek and the Big Hole River. Flood plain alluvium is expected to be mainly silt with some sand and gravel. No particular soils problems are anticipated, although proper drainage may be complicated by the flat topography and the presence of irrigation ditches.

From Station 342 to Station 530 the roadway will be mainly in right side cut with a fill section on the left. On the right low hills, steep bluffs rise abruptly and mark the western limit gently inclined benchlands. On the left, is the existing roadway of U.S. 91 and the valley and flood plain of Divide Creek. No serious problems related to soils or geologic conditions are anticipated in this area. The entire roadway will be built on weakly consolidated Tertiary sediments or gravelly alluvial fans developed at the mouths of ravines and gullies. In the interval from Station 490 to Station 530, some discontinuous roughly lenticular layers of lime cemented gravel crop out in gully walls and road cuts; blasting of this material may be necessary during construction. Near Station 420±, the roadway will be crossing an area of moderate spring activity and some special drainage treatment will be necessary.

From Station 530 to Station 787+65, the alignment moves away from its close parallelism with U.S. 91 and follows a straighter course than the present highway. The route cuts across some benchlands between major streams but in general it follows the line of bluffs which mark the boundary between benchlands in the right and Divide Creek Valley on the left. Geologically, the roadway will be on material very similar to that discussed in the previous section from Station 342 to Station 530. No soils problems are anticipated in this area. At Station 773 the line crosses Curly Gulch and then joins the Hill route at Station 787+30.

Conditions on the Valley route related to soils and geology do not differ greatly from those encountered on the Hill route, except in detail.

Neither route is expected to encounter any serious problems created by poor soils conditions or unusual geologic conditions. However, a comprehensive soils survey and boring program is recommended for both routes with special emphasis on borings in areas of deep cuts, cuts in bentonitic shales, flood plains of major streams and areas of spring activity.

Common Route

From the coincidence of the Hill and Valley route ($V_5 = H_5$) northward to the end of the project, the alignment is roughly parallel to existing U.S. 91 but follows a somewhat straighter course several hundred feet right of U.S. 91. The roadway crosses the East Fork of Divide Creek at Station 824 then begins a long steep ascent (about 3.0%) to the Continental Divide at Station 892. From here the alignment descends a steeper slope (about 4.0%) into the headwaters of Sand Creek, a tributary of the Clark Fork River. On the north side of the Continental Divide, the topography is characterized by interstream areas of moderate relief, separating steep walled ravines. Benchlands similar to those found south of the divide are also developed in this area but are not as sharply defined, probably due to a slightly different erosion history. In this area as elsewhere on the project, tilted and faulted Tertiary sediments constitute the principal foundation material. In this region, however, the Tertiary rocks exhibit less gravel rich strata and more sands, silts and tuffaceous rocks. In the interval from the summit of the Continental Divide to the project terminus at Station 1147+90, the roadway will be in long low cuts alternating with short embankment sections over ravines. No soils or geologic problems are anticipated in this area although construction materials from about Station 824 to Station 1147+90 will probably be finer grained and contain less gravel than elsewhere on the project. Some unconsolidated, coarse, arkosic sands are expected as surficial deposits in the intervals from Station 982 to Station 1012 and Station 1050 to Station 1062.

Summary and Conclusions

Soils classification anticipated on this project, can be summarized as follows. Bentonite outcrops in Tertiary sediments will probably classify as A-7 with group indices ranging from 15 to 20. Most bentonite and bentonitic soils will be found between the beginning of the project and Moose Creek. In much of the area between Moose Creek and Divide, soils will be gravelly and are expected to classify as A-1-a and A-1-b with possible A-2-4 phases. A layer of dense conglomerate (lime cemented) may have to be blasted in the area just south of Divide. From Divide north to the end of the project, we expect a variety of soils types, as Tertiary rocks are made up here on many types. Pure graded sand (A-3), as well as graded and ungraded gravels (A-1-a) and A-2-4 and A-2-7)

finer tuffaceous and clay rich sediments (A-4 to A-6) and some moderately indurated sandstone and conglomerate will be encountered. South of the Continental Divide, the Tertiary sediments contain much gravel and coarse sand. North of the divide, sands and tuffaceous rocks predominate. Flood plain alluvium will probably classify as A-4 or A-6 although some gravel rich phases are anticipated. Pleistocene sediments are expected to be mainly A-2-4 to A-2-6, typically silty sand and gravel although some deposits of unconsolidated sand will be encountered.

In many places "soils classification" will really be the case of "rock type classification" as the roadway will be built in or on weakly consolidated Tertiary sediments. In general, the soils for this project should be good to fair with no extensive problem area anticipated. Problem phases to Tertiary sediments may include pure sand, bentonite, silt or loose volcanic ash, compressible silts or ash are also possible. The existance of poor material in Tertiary sediments will have to be determined during the soils boring program because good exposures are lacking. For this reason, soil investigation borings should be carried to at least 10 feet below design grade in all cut sections, where the roadway will be in Tertiary sediments. In many cases this may involve drilling down through the Pleistocene gravels and into Tertiary below.

Isolated springs have been noted in many places in this region and some free ground water may be encountered during roadway construction. Faults in the Tertiary sediments have been noted as the site of springs. Permeable beds in the Tertiary may also account for some springs. One particularly large area (20 acres±) of intense spring activity was noted near the boundary between sections 22 and 23, T-I-N, R-9-W. The flood plains of larger streams are expected to be the site of some spring activity due to a local, near-surface water table. Special treatment will be in order where more detailed study and soil borings indicate that free ground water may be encountered in cut sections or saturated soil or active springs will be covered by embankment, as at Station 420± on the Valley route.

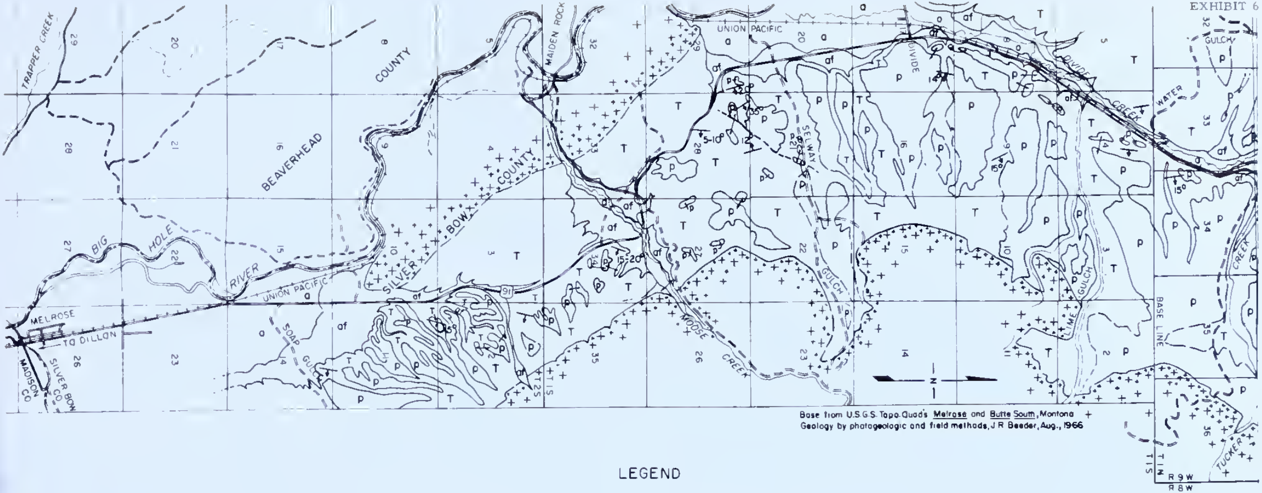
Stable backslope design on the project is not expected to be a problem. For cuts under 15.0' depth (at slope stake) the Montana Highway Commission cut slope standards for rolling terrian will prevail. For deeper cuts, slopes not steeper than 1-1/2:1 should provide stable slopes in most cases. Further detailed soils and subsoils investigations, or earthwork considerations may require special slope design in some places. Interceptor ditches and slope erosion protection are anticipated as important design considerations for the project because of the nondurable easily erodable nature of the bedrock.

Possible borrow sites abound in this region; at present, most gravel pits are confined to alluvial fans developed at the mouth of streams tributary to Divide Creek. However, some small borrow pits are cut in Tertiary gravels and these sediments represent the largest potential source of granular borrow and aggregate. No shortage of good borrow material, if needed, is anticipated.

Rock requiring blasting is expected to be a small quantity on the subject project. On the Hill route probably no solid rock will be encountered. On the Valley route, rock of sufficient induration to require possible blasting will be encountered only in the intervals from Station 283 to Station 300 and from Station 490 to Station 530. All other portions of both routes (to the extent of present knowledge) will be in easily rippable materials.

Both routes appear to be equally feasible as far as geologic and soils conditions are concerned and neither alignment appears to have a strongly defined advantage over the other. Drainage considerations may be more complex on the Valley route but use of the Hill route will necessitate deeper cuts and higher embankments.

Prior to acceptance of the final alignment, possibly before the preliminary Plan-in-hand field review, a comprehensive boring and testing program is recommended. Such a program should be designed to acquire data relative to all routes and connection roads and to verify the findings of this location report.



MATCH LINE
SEE EXHIBIT 7

LEGEND

a	Recent floodplain alluvium, mainly silt, sand and gravel
af	Recent alluvial fans and stream deposits now being dissected by present stream action, composed chiefly of silty sand and gravel
p	Pleistocene alluvium — Mapping includes gravel veneered erosion surfaces, deposits of poorly sorted silt, sand, gravel, cobbles and boulders, some deposits of loose sand. (a variety of deposits originating from meltwater streams)
T	Tertiary valley fill, mainly clastic sediments derived from erosion of adjacent highlands also includes tuffaceous rocks, bentonite, silt and clay. Most sediments are stream deposits, some are lacustrine.
+ +	Igneous, metamorphic and sedimentary rocks older than the Tertiary valley fill.

10°	Strike and dip (Tertiary rocks only)
	Contact
	Approximate contact
	Fault
	Inferred fault

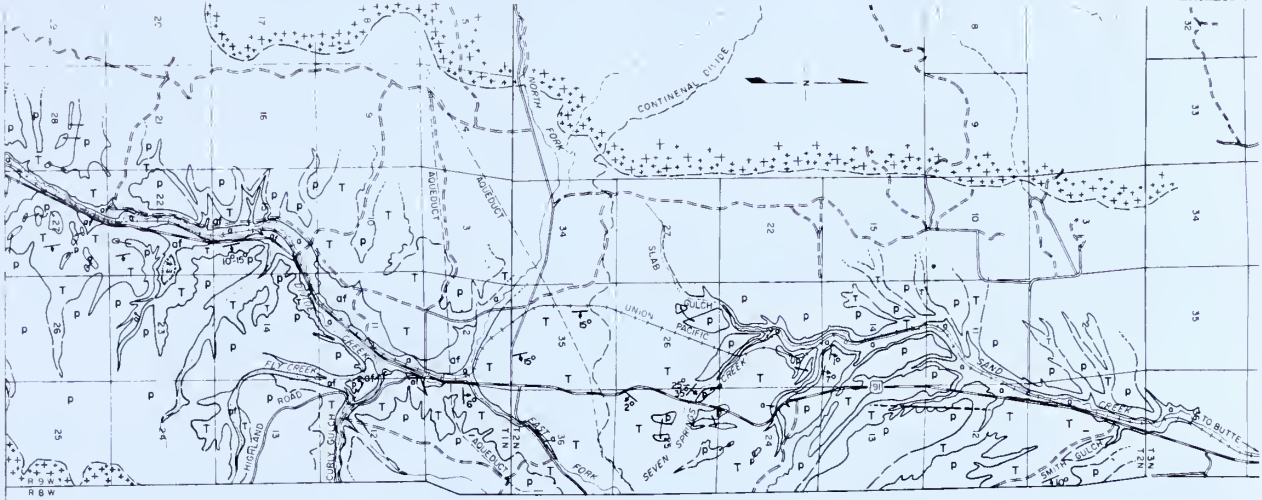
GRAPHIC SCALE

1 1/2 0 1 MILE

GEOLOGIC MAP OF MELROSE, DIVIDE, DEER LODGE PASS & VICINITY, MONTANA

INTERSTATE PROJECTS: I 15-2(11) 96—117

RADER AND ASSOCIATES
Engineers and Architects
Miami, Florida – Helena, Montana



MATCH LINE
SEE EXHIBIT 6

NOTE: FOR LEGEND SEE EXHIBIT 6

GRAPHIC SCALE
1/2 0 1 MILE

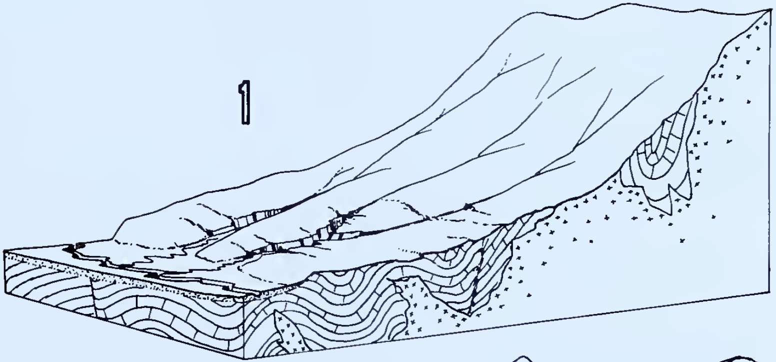
GEOLOGIC MAP OF MELROSE, DIVIDE, DEER LODGE PASS & VICINITY, MONTANA

INTERSTATE PROJECTS: I 15-2(11) 96—117

RADER AND ASSOCIATES
Engineers and Architects
Miami, Florida—Helena, Montana

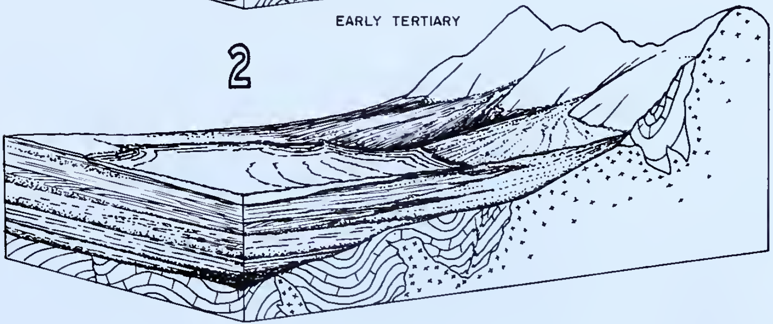
IDEALIZED BLOCK DIAGRAMS SHOWING
TERTIARY TO RECENT GEOLOGIC – PHYSIOGRAPHIC
HISTORY OF DIVIDE CREEK & VICINITY, SILVER BOW COUNTY, MONTANA

1



EARLY TERTIARY

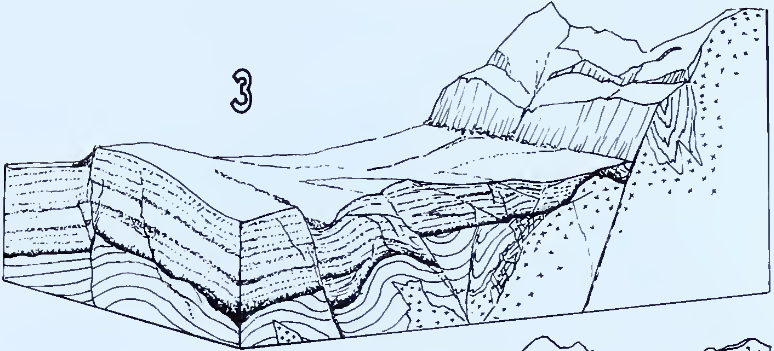
2



EARLY TO MIDDLE TERTIARY VALLEY FILL

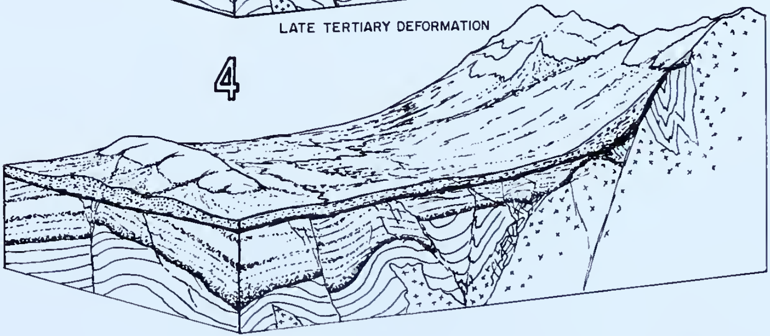
IDEALIZED BLOCK DIAGRAMS SHOWING
TERTIARY TO RECENT GEOLOGIC – PHYSIOGRAPHIC
HISTORY OF DIVIDE CREEK & VICINITY, SILVER BOW COUNTY, MONTANA

3



LATE TERTIARY DEFORMATION

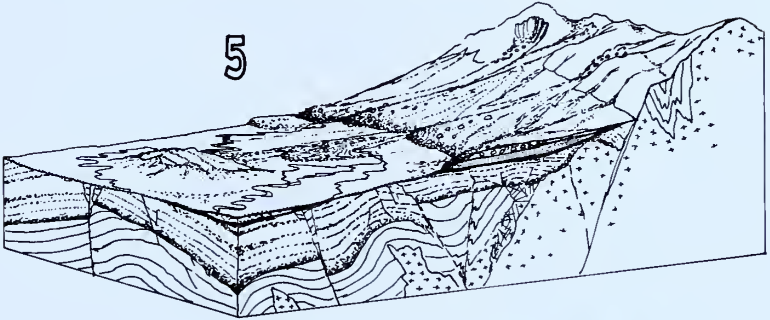
4



LATE TERTIARY EROSION-DEPOSITION

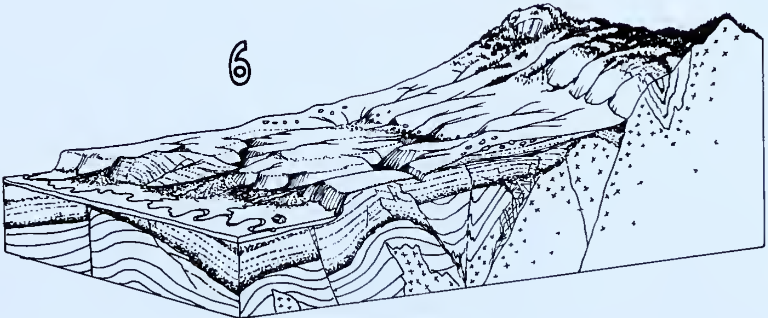
IDEALIZED BLOCK DIAGRAMS SHOWING
TERTIARY TO RECENT GEOLOGIC – PHYSIOGRAPHIC
HISTORY OF DIVIDE CREEK & VICINITY, SILVER BOW COUNTY, MONTANA

5



PLEISTOCENE EROSION—DEPOSITION

6



PRESENT PHYSIOGRAPHY

HYDRAULICS AND DRAINAGE

The alternate routes, as shown in Exhibits 2 and 3, are generally similar in topography, except for elevation, and consequently they can be considered to have the same runoff curve.

Drainage studies along these proposed routes were conducted using U.S. G.S. quadrangle sheets and hydrologic survey data, 1961 aerial photos 1" = 1000', aerial photo reconnaissance contour mapping 1956 (scale 1" = 200', 5' contours) and Montana State Highway Department as-built plans on existing U. S. 91. Most of the drainage areas involved were grass covered devoted to grazing lands with only small areas being irrigated for agricultural use. There was very little tree cover in the immediate vicinity. For preliminary design and cost estimates, large and small drainage structures were designed, and runoff determined, as outlined in "Montana Highway Department Field and Office Standards", and the "Hydraulic Design Series" by the Bureau of Public Roads.

In order to arrive at a proper runoff determination and required sizing of waterway openings, using the above references, comparisons were made, whenever possible, with existing structures along U. S. 91 and the Union Pacific Railway. However, in some locations the available contour maps and field reconnaissance do not fully reveal how drainage is adequately taken care of under the P. T. W. During the final design these situations will be studied thoroughly to arrive at an adequate solution. The basis for runoff calculations was a 50-year frequency design storm.

Discharge records for Moose Creek were obtained from the publication "Small Area Peak-Flow Highway Program in Montana," 1964, by Montana State Highway Commission and Bureau of Public Roads. At the crossing of U. S. 91 and Moose Creek, crest gaging had been performed with the following results:

Maximum discharge recorded; 165 cfs, May 1963

Drainage area involved; 41. 4 square miles

From this determination of discharge, a channel design was formulated capable of handling the peak flood on record, with an additional factor of safety provided by the height of roadway above berms.

Only structures over 54 inches in diameter are shown on the Plan-Profile sheets. Minimum diameter of mainline pipe culverts and median ditch drains will be 24 inches. Minimum diameter of pipe culverts for ramps, intersecting roads and frontage roads will be 18 inches. During the final design, location and size of structures may be subject to modifications from those shown in this study, but it is believed that the estimated cost of drainage structures, as indicated in the report, will be adequate for the final drainage system.

The cost of drainage structures for I 15, under 54 inches in diameter, was based on an average cost per mile. The cost of culverts 54 inches in diameter and over, and cost of stock passes, were estimated individually. It is proposed that drainage under the Interstate and the Frontage Roads will be handled by structural plate culverts in lieu of bridges.

For two local roads, with relatively high traffic, it is proposed that vehicular underpass structures be provided. (See Exhibit 5.) The underpasses have been estimated on the basis of $10. 50 per sq. ft., for an area equal to the overall length and 40 feet wide, exclusive of earthwork. The additional two feet in the width of the structures offset the railing cost.

Vehicular and stock passes have been estimated on the basis of a structural plate pipe arch conforming to Montana Highway Commission standard drawing No. 66-04, design 126.

TABLE 3

DRAINAGE RECOMMENDATIONS

Station	Drainage Area (Acres)	Culvert Size (Inches x Feet)	Cost
H_1 - H_8 Hill Route			
51+80	550	54" x 310'	$10,850.
94+70	810	60" x 230'	9,200.
171+00	26,880	12'-10" x 8'-4" arc x 460'	46,000.
245+50	600	60" x 460'	18,400.
276+20	1,530	72" x 490'	26,950.
310+20	450	54" x 520'	18,200.
343+50	510	54" x 250'	8,750.
389+60	490	54" x 350'	12,250.
409+20	800	60" x 250'	10,000.
428+40	2,110	7'-3" x 5'-3" arc x 430'	23,650.
473+20	505	54" x 410'	14,350.
482+30	525	54" x 380'	13,300.
527+30	7,800	12'-4" x 7'-9" x 270'	20,250.
618+35	780	60" x 400'	16,000.
738+60	8,800	12'-4" x 7'-9" x 240'	18,000.
H_3 - V_4 Connection Road			
473+20	505	54" x 400'	14,000.
480+30	525	54" x 370'	12,950.
528+25	7,800	12'-4" x 7'-9" x 220'	16,500.
V_3 - H_4 Connection Road			
506+00	530	54" x 360'	12,600.
554+75	7,800	12'-4" x 7'-9" x 290'	21,750.

Note: Culverts smaller than 54" not considered individually, but unit costs per mile of alternates, for minor drainage structures, were estimated to be $8,000.

Station	Drainage Area (Acres)	Culvert Size (Inches x Feet)	Cost
V_1 - V_8 Valley Route			
45+00 (S. B.)	570	54" x 110'	$ 3,850.
51+50 (N. B.)		54" x 110'	3,850.
92+50 (S. B.)	830	60" x 110'	4,400.
94+80 (N. B.)		60" x 150'	6,000.
166+25 (S. B.)	26,880	12'-10" x 8'-4" x 260'	26,000.
167+10 (N. B.)		12'-10" x 8'-4" x 240'	24,000.
253+00	635	54" x 280'	9,800.
284+20	1,660	6'-9" x 4'-11" x 230'	10,350.
364+80	910	60" x 250'	10,000.
417+00	1,340	6'-9" x 4'-11" x 240'	10,800.
449+25	2,530	7'-3" x 5'-3" x 230'	12,650.
497+20	510	54" x 320'	11,200.
506+00	530	54" x 360'	12,600.
554+70	7,800	12'-4" x 7'-9" x 240'	18,000.
644+60	1,925	6'-9" x 4'-11" x 240'	10,800.
691x40	870	60" x 300'	12,000.
772+50	8,800	12'-4" x 7'-9" x 240'	18,000.
823+50	3,840	Two 60" x 250'	20,000.
931+30	580	54" x 310'	10,850.
978+80	980	60" x 340'	13,600.
V_2 - H_2 Connection Road			
249+10	635	54" x 260'	9,100.
279+90	1,530	72" x 490'	26,950.
V_{6a} - V_{7a} Connection Road (Sand Ck. Connection Road)			
980+90	980	60" x 310'	12,400.
Major Channel Changes			
Station 44+00 Lt. S. B. Lane		600'	4,300.
Station 48+00 Lt. N. B. Lane		500'	3,500.
Station 186+00 Median Centerline		600'	4,300.
Station 800+00 Lt. Centerline		400'	2,800.

TABLE 4

BRIDGE RECOMMENDATIONS

Station	Length	Deck Width	Deck Area Sq. Ft.	Cost Per	Total Cost
Valley Route					
8+30	240'	126" SPPS		$105.00 l.f.	$ 25, 200
152+00 (S. B.)	125'	40' Single	5000	10. 50 s. f.	52, 500
154+00 (N. B.)	125'	40' Single	5000	10. 50 s. f.	52, 500
282+50	250'	126" SPPS		105. 00 l. f.	26, 250
328+00	110'	40' Dual	8800	10. 50 s. f.	92, 400
416+00	250'	126" SPPS		105. 00 l. f.	26, 250
448+70	250'	126" SPPS		105. 00 l. f.	26, 250
554+00	110'	40' Dual	8800	10. 50 s. f.	92, 400
644+00	250'	126" SPPS		105. 00 l. f.	26, 250
774+00	110	40' Dual	8800	10. 50 s. f.	92, 400
845+00	110	40' Dual	8800	10. 50 s. f.	92, 400
934+00	250'	126" SPPS		105. 00 l. f.	26, 250
1113+20	240'	34' Single (X rd. over I-15 Buxton T. I.)	8160	10. 50 s. f.	85, 680
Sand Creek Connection Road					
934+00	250'	126" SPPS		105. 00 l. f.	26, 250

Station	Length	Deck Width	Deck Area Sq. Ft.	Cost Per	Total Cost
Hill Route					
7+90	250'	126" SPPS		$105. 00 l. f.	$26, 250
154+00	110'	40' Dual	8800	10. 50 s. f.	92, 400
275+00	270'	126" SPPS		105. 00 l. f.	28, 350
327+00	240'	34' Single (X rd. over I-15 Divide T. I.)	8160	10. 50 s. f.	85, 680
408+00	250'	126" SPPS		105. 00 l. f.	26, 250
428+00	260'	126" SPPS		105. 00 l. f.	27, 300
522+00	110'	40' Dual	8800	10. 50 s. f.	92, 400
609+00	270'	126" SPPS		105. 00 l. f.	28, 350
740+00	110'	40' Dual	8800	10. 50 s. f.	92, 400
H_3 to V_4 Connection Road					
526+75	110'	40" Dual	8800	10. 50 s. f.	92, 400
V_3 to H_4 Connection Road					
550+30	110"	40' Dual	8800	10. 50 s. f.	92, 400
V_2 to H_2 Connection Road					
278+60	270'	126" SPPS		105. 00 l. f.	28, 350

CONSTRUCTION COST ESTIMATES

The cost estimates presented in this report are considered conservative but will present each route alternate in an equitable and impartial manner. Unit costs used in preparing these estimates were taken from tabulated average low bid prices for Montana Highway contracts for the years 1965 and 1966.

The following is a list of unit prices used in the preparation of this report:

Surfacing

Estimated on the basis of the typical roadway sections as shown in Exhibits 4 and 5, the total surfacing costs per mile are as follows:
Four-lane Interstate $2350/sta. = $124,080/mi.

Frontage Roads and Crossroads:

Gravel (Frontage Roads)	$120/sta. = $ 6,336/mi.
Gravel (Crossroads)	$180/sta. = $ 9,504/mi.
Paved (Both)	$540/sta. = $28,512/mi.
Interchange Ramps	$725/sta. = $38,280/mi.

Earthwork

Unclassified excavation	$0.47/c.y.
Unclassified borrow	$0.48/c.y.
Overhaul excavation	$0.12/mile yd.
Overhaul borrow	$0.14/mile yd.
Rolling, watering etc.	$0.10/c.y.
Signing	$60/sta. (Length of Hwy.) Interchange Signing Lump Sum $16,000 ea.
Guard rail	$275/sta. (Over 12' Fill, Length of Rail)
Right of Way fencing	$35/sta. (Length of Fence)
	$30/sta. (Fence Outside Access Control)

Major Drainage	Tabulated Value
Minor Drainage	$8,000/mi.

Bridges $10.50/s.f.
I 15 over Crossroad (40' Wide*)
Crossroad over I 15 (34' Wide*)

*includes 2' extra width for rail costs.

Maintenance Cost

I 15 Four-lane Roadway	$3,500/mi.
Frontage Roads and Crossroads:	
Paved	$ 500/mi.
Gravel	$ 300/mi.
Present U.S. 91 Primary Highway	$1,800/mi.

TABLE 5

CONSTRUCTION COST SUMMARY
ALTERNATE ROUTES

Route Segment	Station Limits	Length L.F.	Length Miles	Earthwork	Surfacing & Guard Rail	Fencing & Signing	Major Drainage	Underpasses Bridges	Minor Drainage	Cross Road Frontage Road	Total Construction Cost
$V_1 - V_2$	4+40 to 221+90 (Equa. - 42')	21,708	4.111	$1,395,190	$591,720*	$48,410	$80,090	$130,200	$32,890	$11,780	$2,290,280
$V_2 - V_3$	221+90 to 504+00	28,210	5.343	1,280,640	754,270*	56,960	64,800	171,150	42,740	12,260	2,382,820
$V_3 - V_4$	504+00 to 615+30	11,130	2.108	598.860	280,330	14,470	30,600	92,400	16,860	1,260	1,034,780
$V_4 - V_5$	615+30 to 787+30	17,200	3.258	484,150	429,140	22,360	40,800	118,650	26,060	8,040	1,129,200
$V_5 - V_6$	787+30 to 930+00 (Equa.-800+50=Bk 803+50 hh.)	13,970	2.646	331,480	373,350*	38,390	24,940	92,400	21,170	5,530	887,260
$V_6 - V_7$	930+00 to 997+30	6,730	1.275	261,360	166,450	8,750	24,450	26,250	10,200	3,240	500,700
$V_7 - V_8$	997+30 to 1147+90	15,060	2.852	171,990	392,620*	40,650	000000	85,680	22,820	33,870	747,630
$H_1 - H_2$	4+40 to 276+60	27,220	5.155	1,869,260	718,410*	55,670	111,400	147,000	41,240	13,580	2,956,560
$H_2 - H_3$	276+60 to 441+70	16,510	3.127	436,410	432,910*	41,750	72,850	139,230	25,020	30,580	1,178,750
$H_3 - H_4$	441+70 to 559+40	11,770	2.229	436,720	287,440	15,300	47,900	92,400	17,830	1,350	898,940
$H_4 - H_5$	559+40 to 753+00	19,360	3.667	813,000	471,910	25,170	34,000	120,750	29,340	5,270	1,499,440
$V_2 - H_2$	221+90 to 280+30	5,840	1.106	309,000	152,630	7,590	36,050	28,350	8,850	50	542,520
$V_3 - H_4$	504+00 to 586+65	8,265	1.565	546,790	197,210	10,740	34,350	92,400	12,520	1,080	895,090
$H_3 - V_4$	441+70 to 589+00	14,730	2.790	729,790	357,320	19,150	43,450	92,400	22,320	900	1,265,330
$V_{6a} - V_{7a}$	930+00 to 999+10	6,910	1.309	233,410	173,970	8,990	12,400	26,250	10,470	3,240	468,730

* Includes Traffic Interchange Ramps, Guard Rail, and Cattle Guard.

TABLE 6

ACCESS FACILITY STUDY

Approximate Valley Route Station	Route Designa-tion	Road Use	ADT 1990 Assumed	Type Local Access Facility Proposed
8 Rt.	V	Trail	≤ 10	Fr. Rd. down left side (Alt. Access available).
	H	Trail	≤ 10	Use existing U.S. 91 Fr. Rd. Lt. w/vehicular underpass.
14 Lt.	V	Trail	≤ 10	Fr. Rd. to beginning Project 1/4 mile.
	H	Trail	≤ 10	Use existing U.S. 91 as Fr. Rd.
53 Rt.	B	Trail	≤ 10	None
152 Lt. & Rt.	B	Trail	≤ 10	Fr. Rd. from Moose Creek T.I.
176 Lt. & Rt.	B	Moose Creek Rd.	≤ 300	T.I. with Fr. Rd. on Lt. Use U.S. 91 back from T.I. to Rd. on Rt.
206 Lt. & Rt.	B	Trail	≤ 10	None (To be determined by damage values).
282 Lt. & Rt.	B	Farm Access	≤ 10	Existing U.S. 91 as Fr. Rd. from Divide T.I. Vehicular Underpass.
354	B	Montana Hwy. 43	≤ 750	T.I. with Fr. Rd., U.S. 91, East & West.
413 Lt.	B	Ranch Access	≥ 10	Fr. Rd. existing U.S. 91.
413 Rt.	B	Ranch Access	≥ 10	None
449 Rt.	B	Lime Gulch Trail	≥ 10	Vehicular underpass (Property owner determination Alt. access available) Fr. Rd. down Rt. side from Sta. 413+
470	B	Farm Access	≤ 10	Fr. Rd. existing U.S. 91.
493 Lt.	B	Farm Access	≤ 10	Fr. Rd. Existing U.S. 91.

Approximate Valley Route Station	Route Designa- Designa-	Road Use	ADT 1990 Assumed	Type Local Access Facility Proposed
565 Lt. & Rt.	B	Tucker Creek Rd.	≥ 10	Fr. Rd. U.S. 91 from Divide T.I. - I 15 Overpass
640 Lt.	B	Gravel Pit	≤ 10	Fr. Rd. U.S. 91 from Feely T.
640 Rt.	B	Trail	≤ 10	Vehicular underpass.
665 Lt.	B	Ranch Access	≤ 10	Fr. Rd. on U.S. 91 from T.I. Feely.
702 Lt.	B	Ranch Access	≤ 10	Fr. Rd. on U.S. 91 from T.I. Feely.
766 Lt.	B	Ranch Access	≤ 10	Fr. Rd. on U.S. 91 from T.I. Feely.
797 Lt.	B.	Highland Rd.	≥ 10	Fr. Rd. U.S. 91 to Feely T.I.
797 Rt.	B	Highland Rd.	≥ 10	I 15 overpass to U.S. 91.
845 Lt. & Rt.	B	Divide Creek Rd.	≥ 50	T.I. - I 15 over Feely.
884 Lt. & Rt.	B	Aqueduct Rd.	≤ 10	Fr. Rd. U.S. 91 from T.I. Use Trail from T.I. Rt. side.
945 Lt.	B	Seven Spring Creek Road	≤ 10	Fr. Rd. U.S. 91.
955 Lt.	B	Farm Access	≤ 10	Fr. Rd. U.S. 91 from T.I.
995 Lt. & Rt.	B	Farm Access	≤ 10	Fr. Rd. U.S. 91 from T.I. Fr. Rd. down from T.I.
1035 Lt. & Rt.	B	Ranch Access	≤ 10	Use U.S. 91 as Fr. Rd. Fr. Rd. down Rt. side from T.I. Sta. 1113+
1070 Lt.	B	Farm Access	≤ 10	Use U.S. 91 as Fr. Rd.
1098	B	Ranch Access	≤ 10	Fr. Rd. down Rt. side to 1113+ Buxton Interchange.
1113 Lt.	B	Buxton Rd.	≤ 150	Interchange
1113 Rt.	B	Ranch Access	≤ 10	Interchange

LEGEND

T.I. = Traffic Interchange

Trail = no known houses

Fr. Rd. = Frontage Road

Ranch Access = to houses

Farm Access = major farm access to growing or grazing area

I 15 overpass structure = 110' x 40' each

Vehicular underpass = D-126
126" SPPS

Route designation

V = Valley Route
H = Hill Route
B = Both Routes

BENEFIT COST ANALYSIS

For the purposes of this study, no capital recovery factor was used in determining Annual Cost, and only the following Amortization periods were assumed for the years of life for the various highway construction items.

Right of Way	50 years
Grading (Including Excavation, Clearing and Grubbing)	40 years
Surfacing (Including Surfacing, Base, Guardrail, Signing, and Fencing)	20 years
Structures (Including Major and Minor Drainage Structures)	40 years

All Alternate Routes were compared to present U. S. 91, which was assumed to be the basic condition. The annual cost comparisons are shown in Tables 9 and 10.

ROAD USER COSTS

A road user cost analysis was made on several alternate sections for the Valley and Hill routes to determine the most desirable alignment for each route. These figures are shown in Tables 7 and 8.

The road user costs were obtained by using "Suggested Motor Vehicle Operating Cost Figures for use in Transportation Studies" furnished by the Montana Highway Commission. In figuring User Costs, the year 1980 was used, as it is the mid year between highway construction and the design year of 1990.

The benefit/cost ratio provides another means of comparing the relative merits of alternate highway routings. Under this procedure, each route was compared with the existing U. S. 91 in order to determine whether the benefits of reduced travel cost for the new routes exceed the extra costs of constructing and maintaining these new routes. The following shows the results of these computations:

Alternate Routes	$\frac{\text{Benefit}}{\text{Cost}}$ Ratios
AG	$\frac{2,349,770 - 1,881,970}{382,970 - 72,800} = 1.51$
BG	$\frac{2,349,770 - 1,933,380}{395,980 - 72,800} = 1.29$
*CG	$\frac{2,349,770 - 1,898,000}{378,720 - 72,800} = 1.48$
DG	$\frac{2,349,770 - 1,948,560}{398,960 - 72,800} = 1.23$
EG	$\frac{2,349,770 - 1,859,680}{383,080 - 72,800} = 1.58$
AF	$\frac{2,349,770 - 1,879,200}{383,440 - 72,800} = 1.51$
BF	$\frac{2,349,770 - 1,930,610}{396,470 - 72,800} = 1.30$
CF	$\frac{2,349,770 - 1,895,230}{379,210 - 72,800} = 1.48$

Although it is not realistic to assume that it would be practical to maintain the present highway indefinitely, without major reconstruction, the present conditions still provide a suitable basis for the comparison of the new routes.

It can be noted, from the above figures, that the benefit/cost ratios of the various alternate alignments have relatively small margins. Consequently, the determination of the most economical route could not justifiably be based on the benefit/cost ratio study; but, other factors were considered in the selection of the recommended route.

*Recommended Route

TABLE 7

ANNUAL ROAD USER COSTS

PROJECT NO. I 15-2(11)96-117

Route Segment	Grade Class %	Length (Miles)	Running Speed (mph)	ADT 1962	ADT 1975	ADT 1990	ADT 1980	DHV 1980	Type of Operation	A_p	A_t	*FA_t	A_e	U	** Total Annual Road User Costs
$V_1 - V_2$	0-3	.723	56	739	1700	2450	1975	240	F	1777	198	495	2272	.0952	$ 57,080
	3-5	3.388	56	739	1700	2450	1975	240	F	1777	198	990	2767	.0985	337,040
$V_2 - V_3$	0-3	4.451	56	826	1900	2800	2200	276	F	2002	198	495	2497	.0952	386,190
	3-5	.892	56	826	1900	2800	2200	276	F	2002	198	990	2992	.0985	95,950
$V_3 - V_4$	0-3	2.108	56	826	1900	2800	2200	276	F	2002	198	495	2497	.0952	182,900
	3-5														
$V_4 - V_5$	0-3	3.258	56	826	1900	2800	2200	276	F	2002	198	495	2497	.0952	282,680
	3-5														
$V_5 - V_8$	0-3	6.072	56	800	1850	2750	2150	266	F	1956	194	485	2441	.0952	515,030
	3-5	.701	56	800	1850	2750	2150	266	F	1956	194	970	2926	.0985	73,740
($V_{6a} - V_{7a}$	Additional $2,770 to $V_5 - V_8$)														
$V_2 - H_2$	0-3	.782	56	739	1700	2450	1975	240	F	1777	198	495	2272	.0952	61,740
	3-5	.324	56	739	1700	2450	1975	240	F	1777	198	990	2767	.0985	32,230
$V_3 - H_4$	0-3	1.565	56	826	1900	2800	2200	276	F	2002	198	495	2497	.0952	135,790
$H_3 - V_4$	0-3	2.790	56	826	1900	2800	2200	276	F	2002	198	495	2497	.0952	242,080
$H_1 - H_2$	0-3	1.985	56	739	1700	2450	1975	240	F	1777	198	495	2272	.0952	156,710
	3-5	3.170	56	739	1700	2450	1975	240	F	1777	198	990	2767	.0985	315,350
$H_2 - H_3$	0-3	3.127	56	826	1900	2800	2200	276	F	2002	198	495	2497	.0952	271,320
	3-5														
$H_3 - H_4$	0-3	1.812	56	826	1900	2800	2200	276	F	2002	198	495	2497	.0952	157,220
	3-5	.417	56	826	1900	2800	2200	276	F	2002	198	990	2992	.0985	44,860
$H_4 - H_5$	0-3	2.379	56	826	1900	2800	2200	276	F	2002	198	495	2497	.0952	206,420
	3-5	1.288	56	826	1900	2800	2200	276	F	2002	198	990	2992	.0985	138,550

* F: 1 Truck = 2.5 passenger cars for 0-3%; 1 Truck = 5 passenger cars for 3-5%

** ARUC = 365 A_e L U

TABLE 8

ANNUAL ROAD USER COSTS

EXISTING ROADWAY

*Type of Operation	Grade Class %	Design Speed (mph)	Annual Running Speed (mph)	Horizontal Curvature Class (Length in Miles) 0° - 3°	4°	5°	6°	7°	8°	9°	10°	12°	18°	20°	Curvature Correction Factor	Equivalent Passenger Vehicle 1980	Total Road User Cost Per Veh. Mile	Total Annual Road User Cost
R	0 - 3	50	36	14.760	-	-	-	-	-	-	-	-	-	-	1.00	2400	.1103	$1,426,150
R					.564	-	-	-	-	-	-	-	-	-	1.08	2400	.1191	58,840
R							.057	-	-	-	-	-	-	-	1.14	2400	.1257	6,280
R											.237	-	-	-	1.25	2400	.1379	28,630
R	3 - 5	50	36	3.220	-	-	-	-	-	-	-	-	-	-	1.00	2900	.1119	381,400
R					.123	-	-	-	-	-	-	-	-	-	1.08	2900	.1209	15,740
R									.153	-	-	-	-	-	1.25	2900	.1399	22,660
R											.305	-	-	-	1.30	2900	.1455	46,970
R													.049	-	1.50	2900	.1679	8,710
R	5 - 7	45	32	1.761	-	-	-	-	-	-	-	-	-	-	1.00	3000	.1166	224,840
R						.144	-	-	-	-	-	-	-	-	1.10	3000	.1283	20,230
R							.063	-	-	-	-	-	-	-	1.14	3000	.1329	9,170
R								.402	-	-	-	-	-	-	1.20	3000	.1399	61,580
R										.081	-	-	-	-	1.25	3000	.1458	12,930
R												.076	-	-	1.30	3000	.1516	12,620
R														.068	1.50	3000	.1749	13,020
				Length = 22.063 Miles												TOTAL -		$2,349,770

* Existing roadway would be +125% practical capacity; therefore, restrictive operation. (R)

ADT = 2800
30 HV = 32% (2400) = 768 vph (Seasonal)
Practical Capacity of existing 2 lane roadway = 600 vph
768/600 = 1.28 $\geq$ 1.25; therefore, restricted operation

ARUC = 365 A_e L U

TABLE 9

ANNUAL COST

Route Designation	Length Miles	R/W 50 yrs.	CONSTRUCTION Grading 40 yrs.	Structures 40 yrs.	Surfacing 20 yrs.	MAINTENANCE Frontage Roads	Cost/Year Cross Roads	Interstate	Road Users Cost	Total Annual Cost
AG	20.985	$1, 500	$107, 310	$29, 380	$158, 400	$11, 900	$1, 030	73, 450	$1, 881, 970	$2, 264, 940
BG	21.627	3, 300	112, 390	28, 580	164, 880	9, 760	1, 380	75, 690	1, 933, 380	2, 329, 360
**CG	21.047	1, 970	103, 180	29, 800	159, 620	9, 240	1, 250	73, 660	1, 898, 000	2, 276, 720
DG	21.493	3, 110	119, 310	28, 530	162, 670	8, 860	1, 250	75, 230	1, 948, 560	2, 347, 520
EG	21.136	1, 680	106, 410	29, 410	159, 920	10, 550	1, 130	73, 980	1, 859, 680	2, 242, 760
AF	20.951	1, 490	108, 010	29, 670	158, 010	11, 900	1, 030	73, 330	1, 879, 200	2, 262, 640
BF	21.592	3, 300	113, 090	28, 880	164, 490	9, 760	1, 380	75, 570	1, 930, 610	2, 327, 080
CF	21.013	1, 960	103, 880	30, 090	159, 240	9, 240	1, 250	73, 550	1, 895, 230	2, 274, 440
Present U.S. 91 (Primary)	22.063				33, 090*			39, 710*	2, 349, 770	2, 422, 570

Resurface U.S. 91 $30, 000/mi.
Maintain U.S. 91 $ 1, 800/mi.

** Recommended Route

TABLE 10

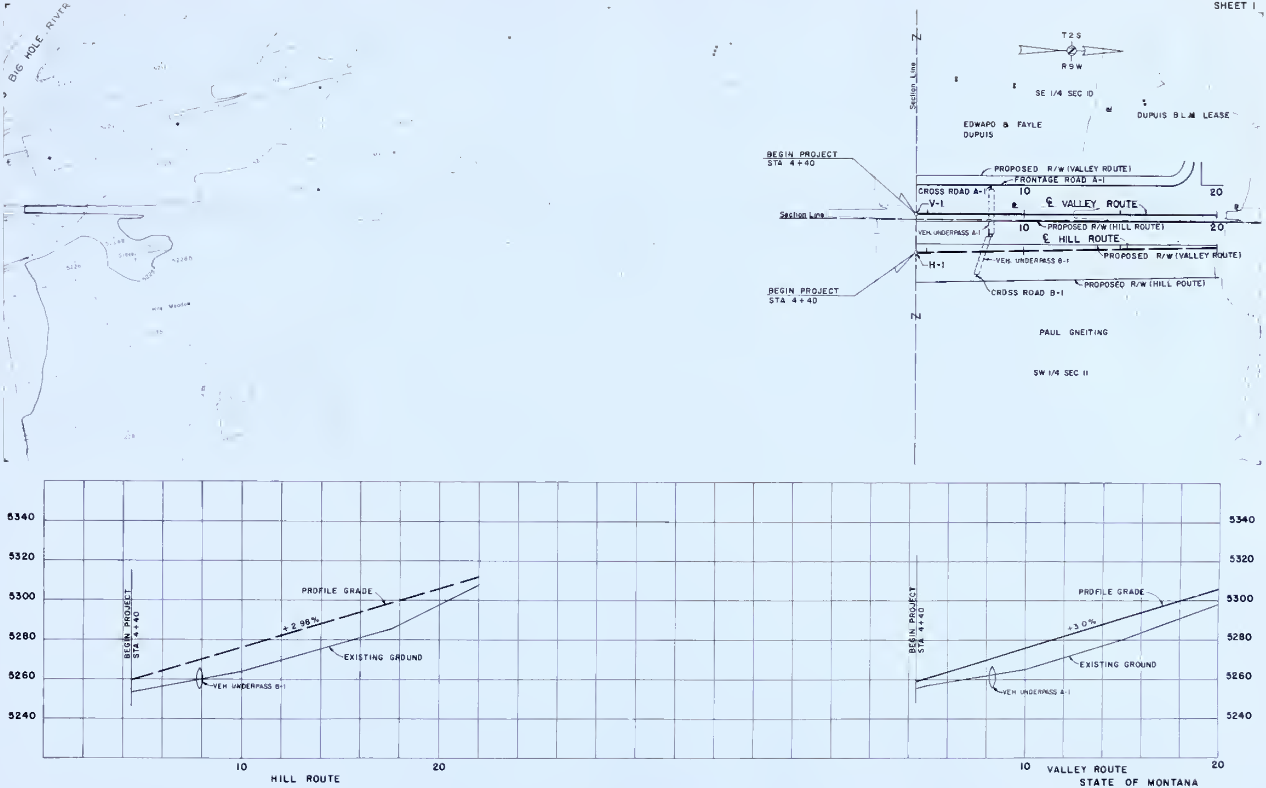
ANNUAL TOTAL COST AND SAVINGS

The final comparisons of the alternate routes must take into consideration three different factors which are of interest to the highway user; namely, annual maintenance costs, annual construction, and annual vehicle operating cost.

Alignment Designation	Annual Maintenance Cost	Annual Construction & R/W Cost	Annual Operating Cost	Total All Annual Costs	Annual Savings over Present Route
AG	$86, 380	$296, 590	$1, 881, 970	$2, 264, 940	$157, 630
BG	86, 830	309, 150	1, 933, 380	2, 329, 360	93, 210
**CG	84, 150	294, 570	1, 898, 000	2, 276, 720	145, 850
DG	85, 340	313, 620	1, 948, 560	2, 347, 520	75, 050
EG	85, 660	297, 420	1, 859, 680	2, 242, 760	179, 810
AF	86, 260	297, 180	1, 879, 200	2, 262, 640	159, 930
BF	86, 710	309, 760	1, 930, 610	2, 327, 080	95, 490
CF	84, 040	295, 170	1, 895, 230	2, 274, 440	148, 130
Present U.S. 91	39, 710	33, 090*	2, 349, 770	2, 422, 570	-------

* This amount is for resurfacing only, existing horizontal and vertical alignment would eventually have to be improved at a considerable additional construction cost.

**Recommended Route.



GRAPHIC SCALE
200 0 200 400 FT

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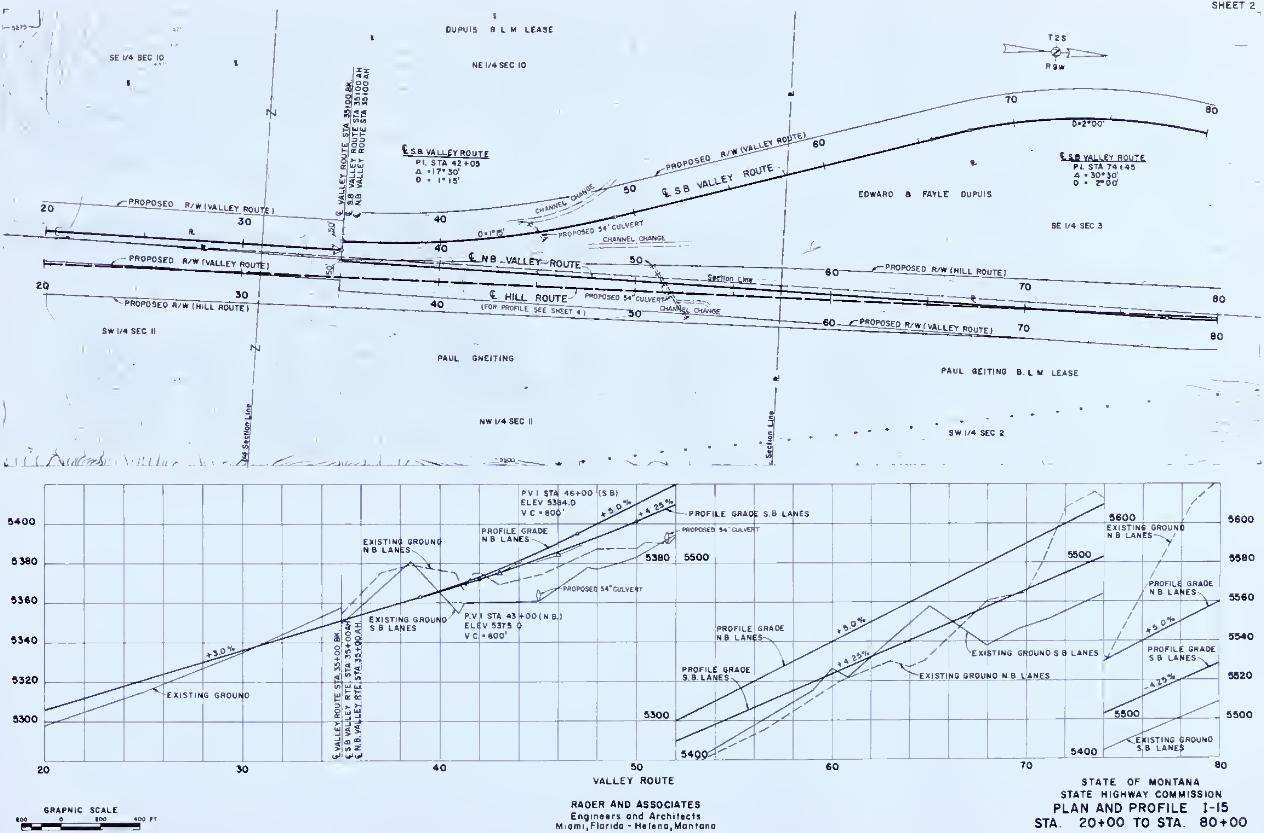
STATE HIGHWAY COMMISSION
PLAN AND PROFILE I-15
STA. 4+40 TO STA. 20+00



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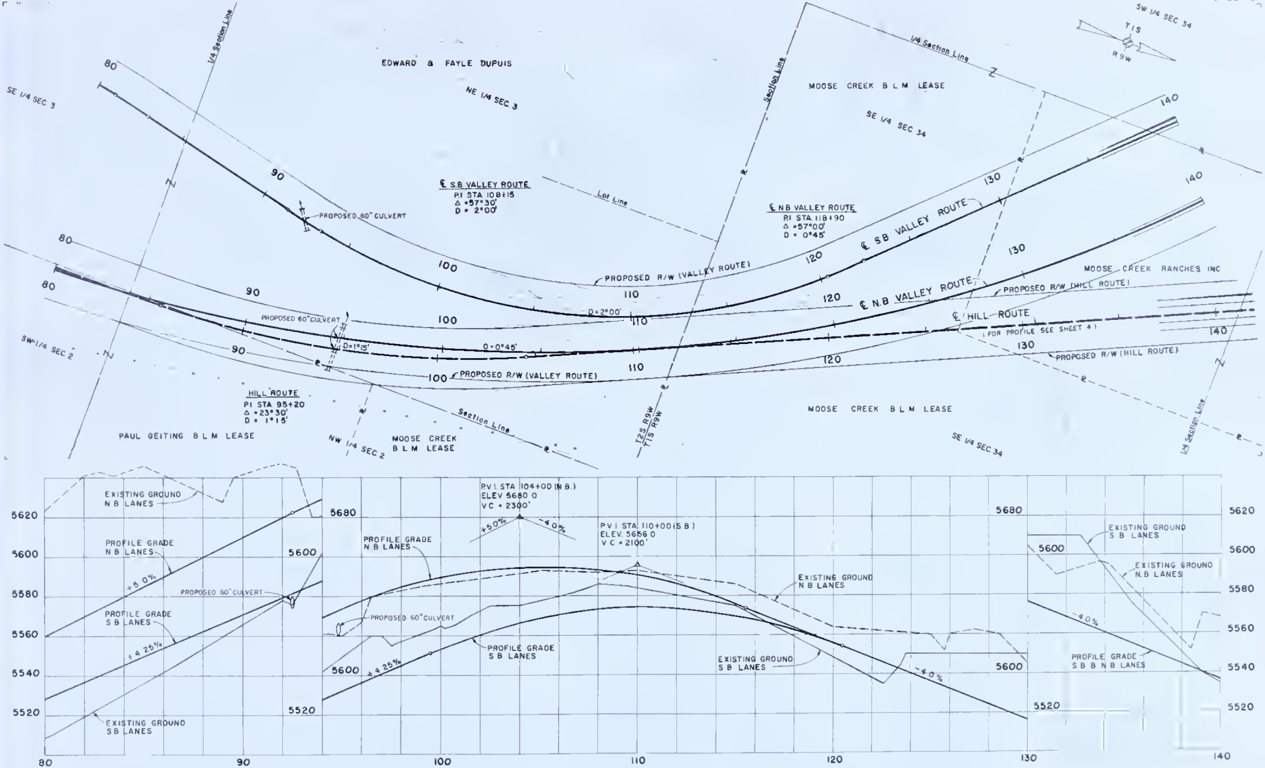
PLAN AND PROFILE I-15
STA. 20+00 TO STA. 80+00



VALLEY ROUTE

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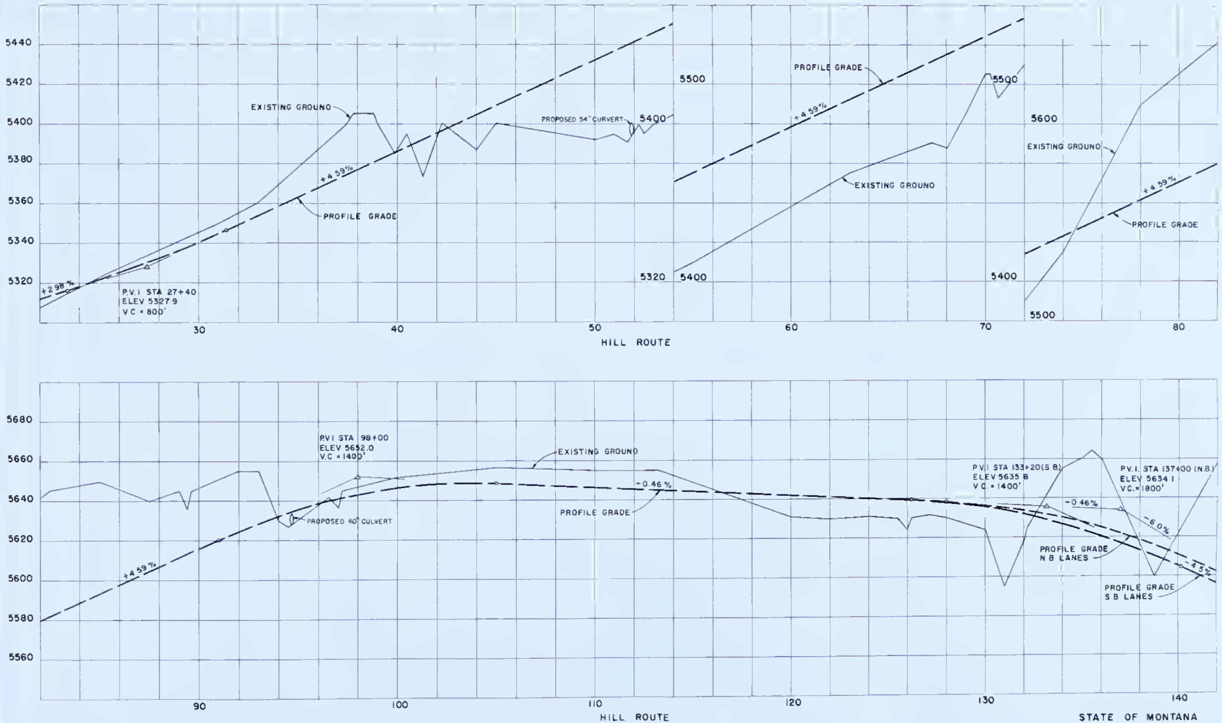
STA. 80+00 TO STA. 140+00



GRAPHIC SCALE
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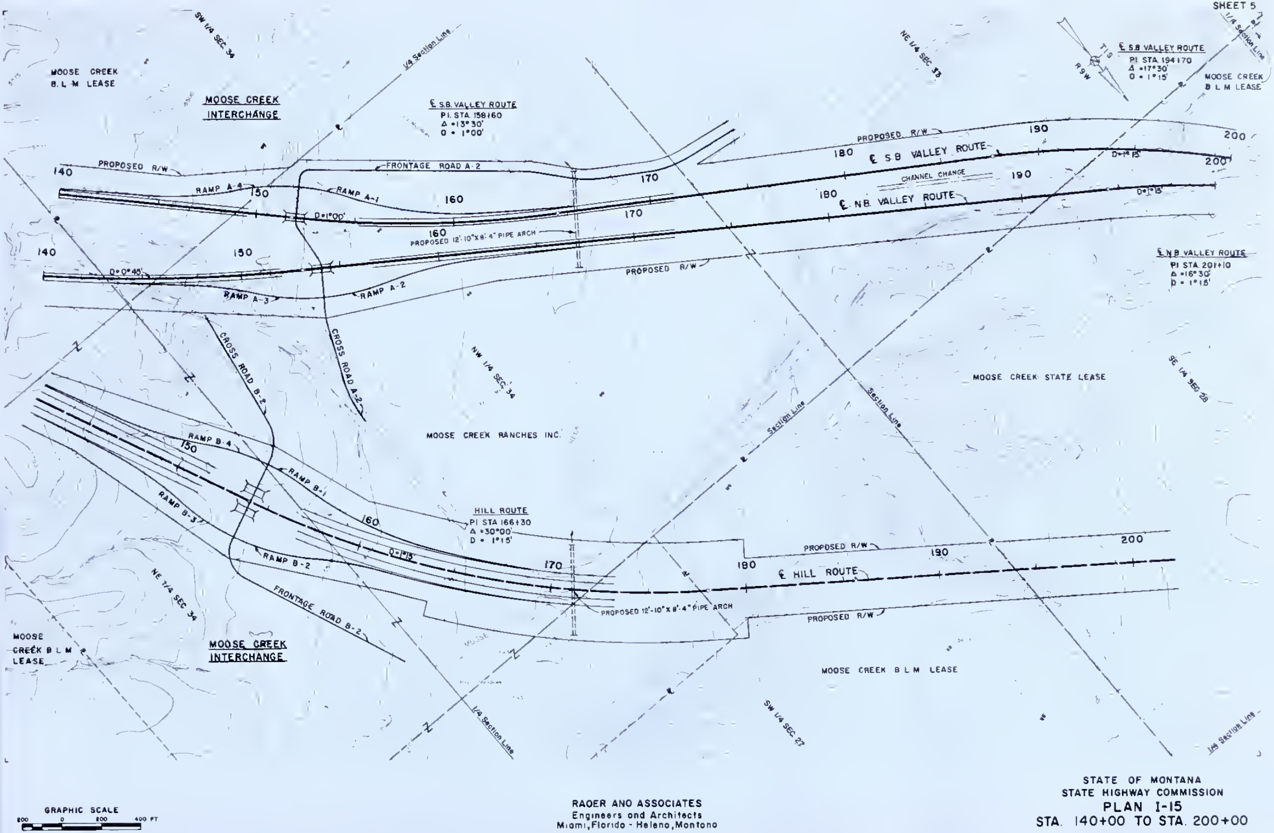
PROFILE I-15
STA. 22 + 00 TO STA. 142 + 00

SHEET 5



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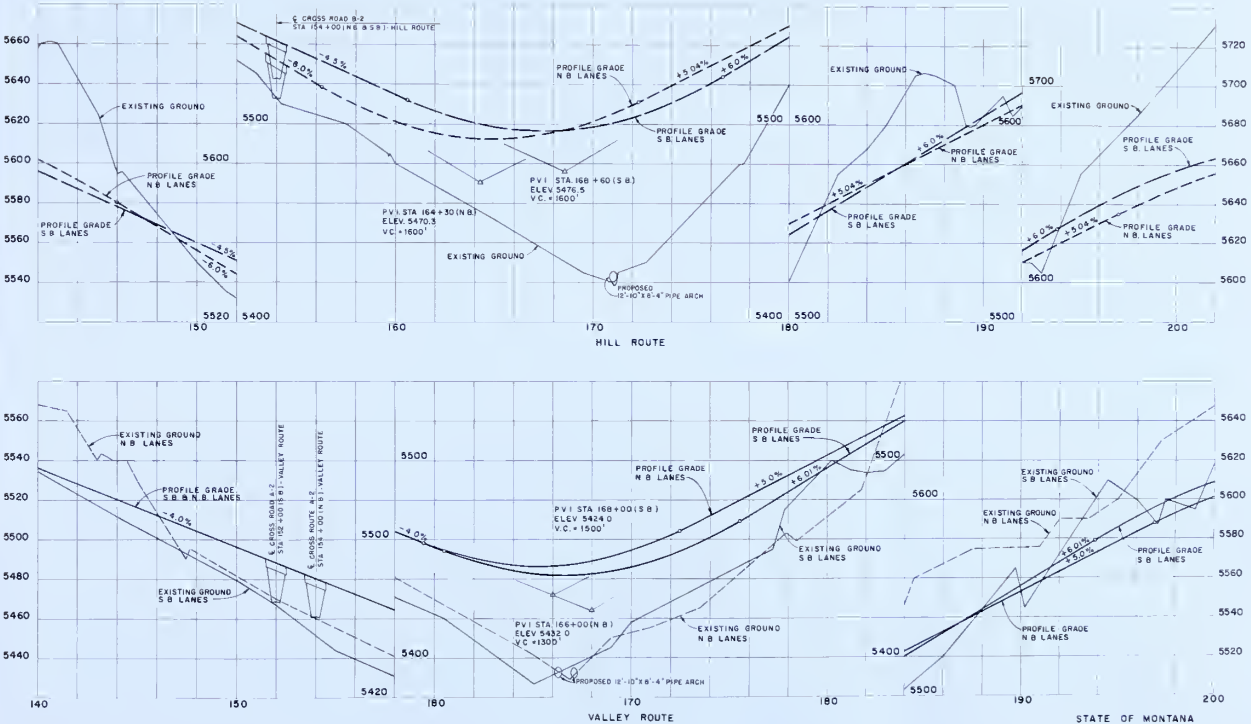
PLAN I-15
STA. 140+00 TO STA. 200+00



GRAPHIC SCALE

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STATE OF MONTANA
STATE HIGHWAY COMMISSION
PROFILE I-15
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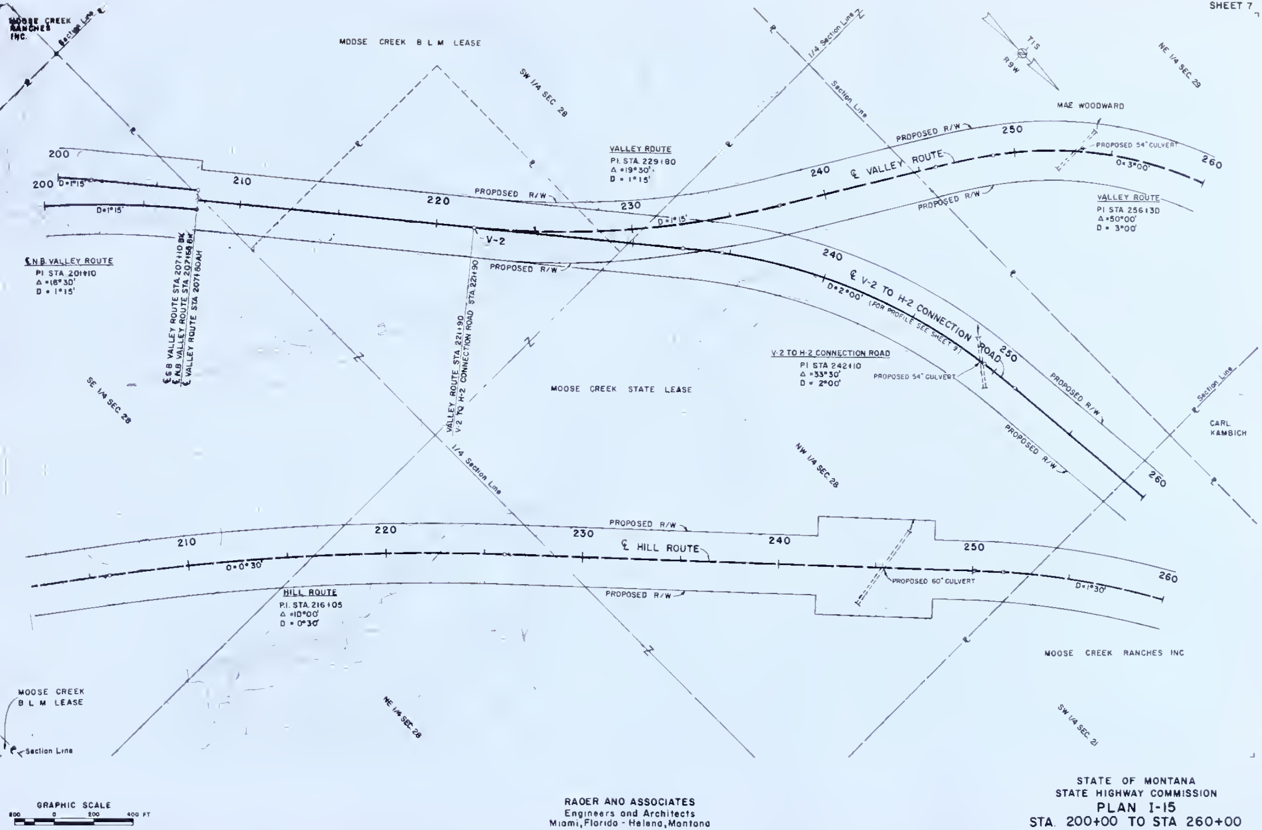

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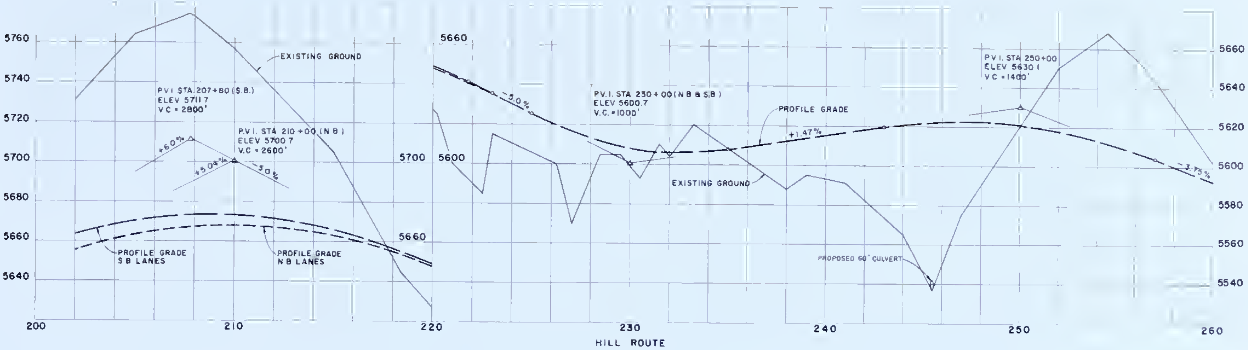
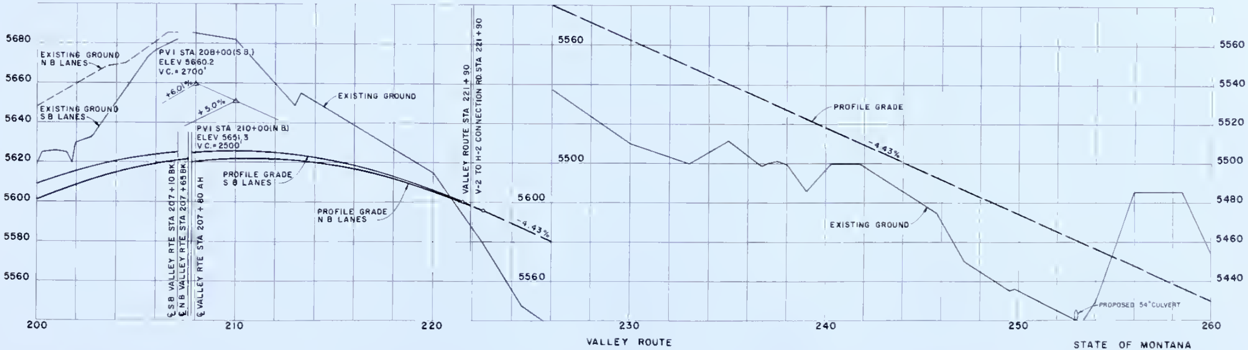
STATE OF MONTANA
STATE HIGHWAY COMMISSION
PLAN I-15
STA. 200+00 TO STA 260+00





GRAPHIC SCALE

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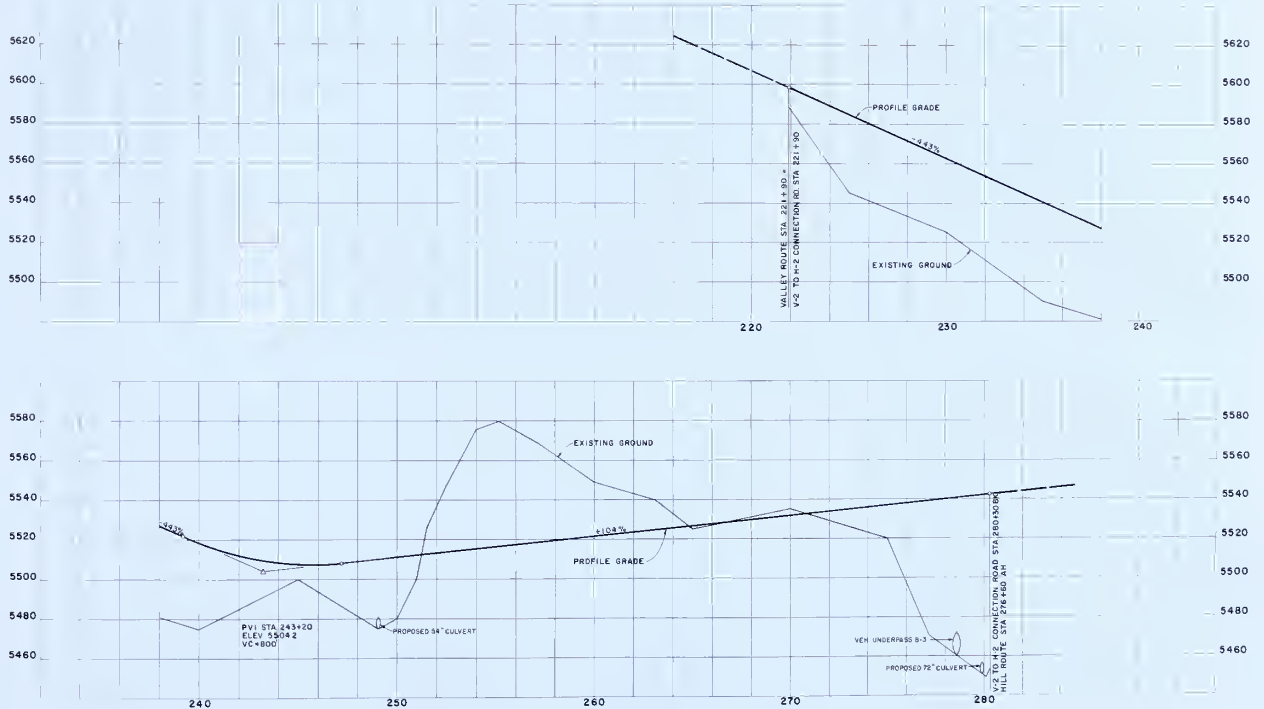
STATE OF MONTANA
STATE HIGHWAY COMMISSION
PROFILE I-15
STA. 200+00 TO STA. 260+00



GRAPHIC SCALE

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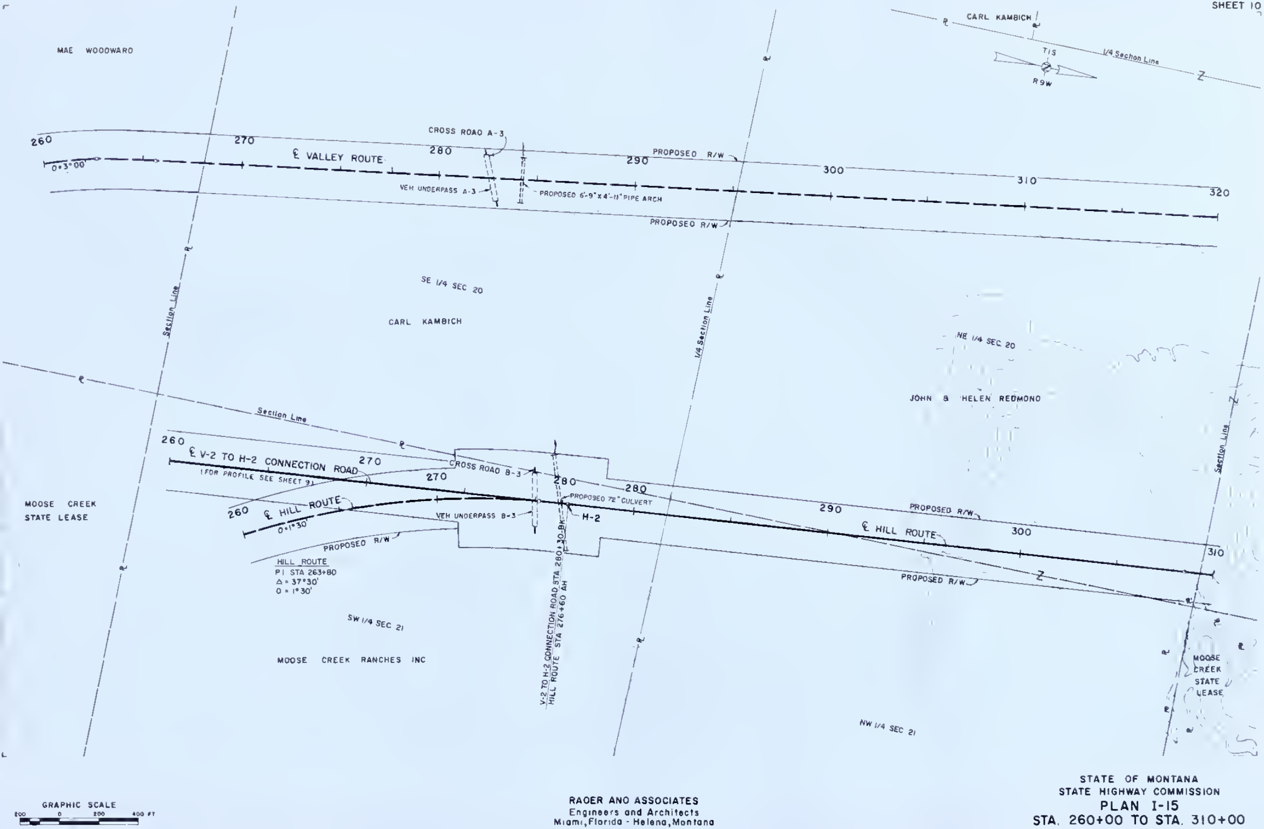
STATE OF MONTANA
STATE HIGHWAY COMMISSION
PROFILE V-2 TO H-2 CONNECTION ROAD
STA. 221+90 TO STA. 280+30



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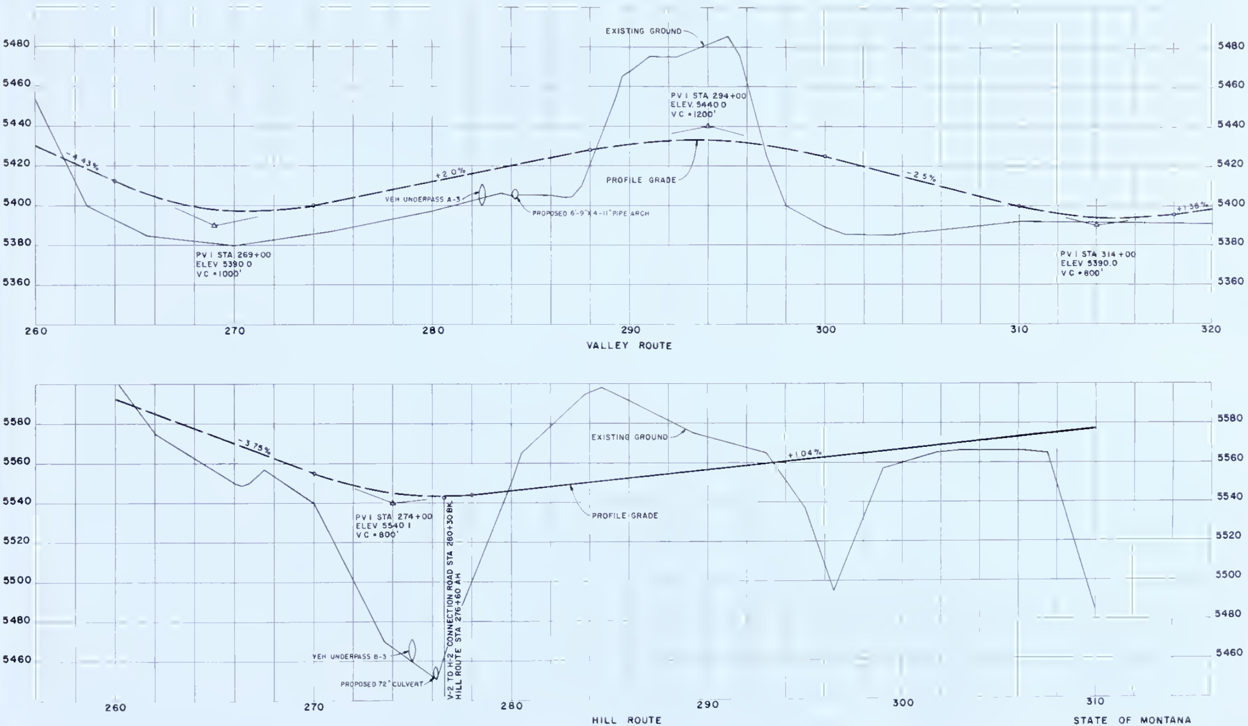
STATE HIGHWAY COMMISSION
PLAN I-15
STA. 260+00 TO STA. 310+00



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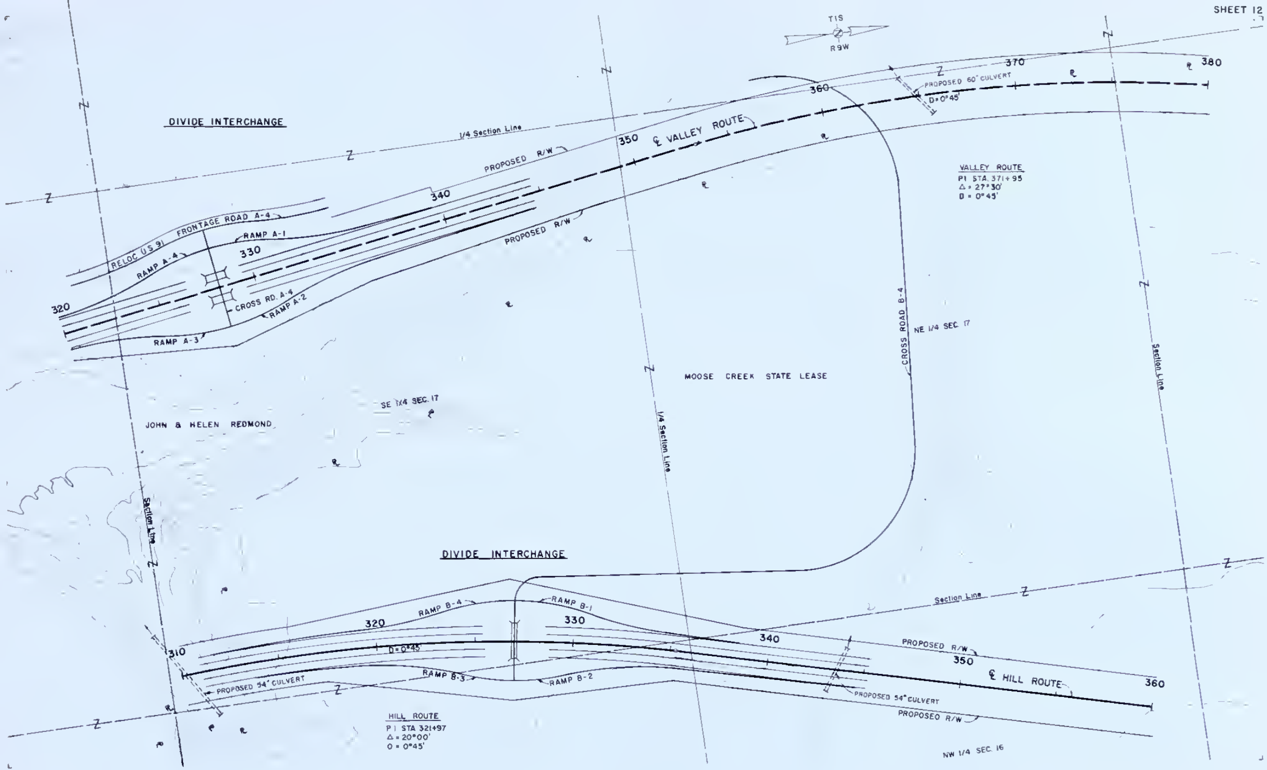
PROFILE I-15
STA. 260+00 TO STA 310+00



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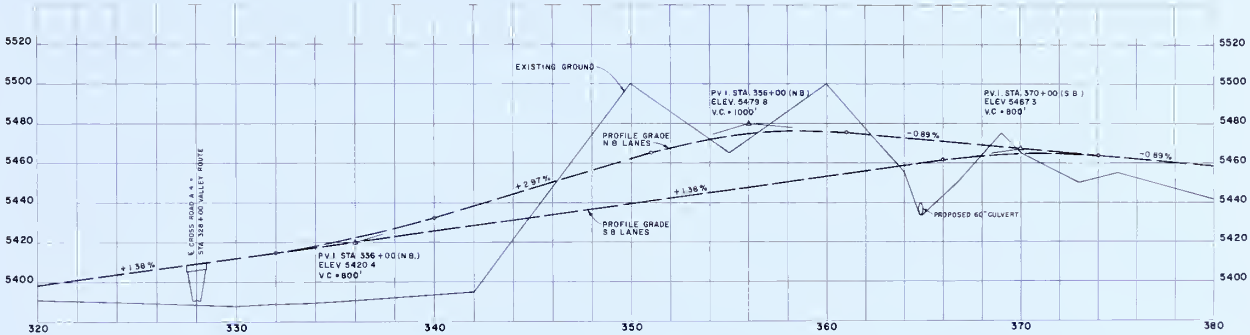
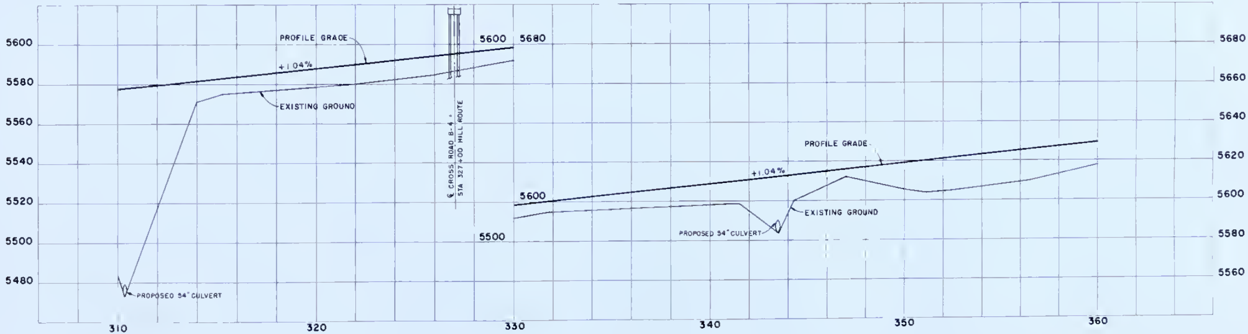
STATE HIGHWAY COMMISSION
PLAN I-15
STA. 310+00 TO STA. 360+00



VALLEY ROUTE



HILL ROUTE

GRAPHIC SCALE

200 0 200 400 FT

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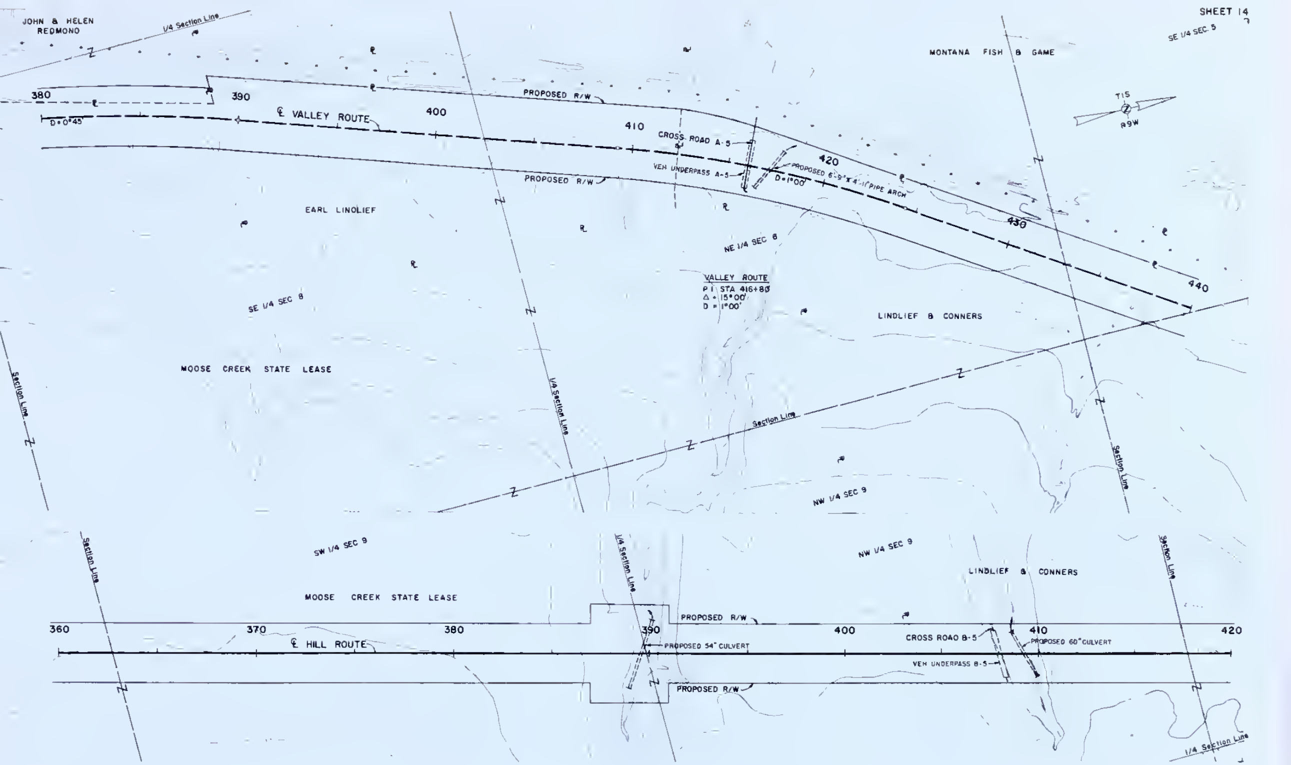
STATE OF MONTANA
STATE HIGHWAY COMMISSION
PROFILE I-15
STA. 310+00 TO STA. 360+00



GRAPHIC SCALE

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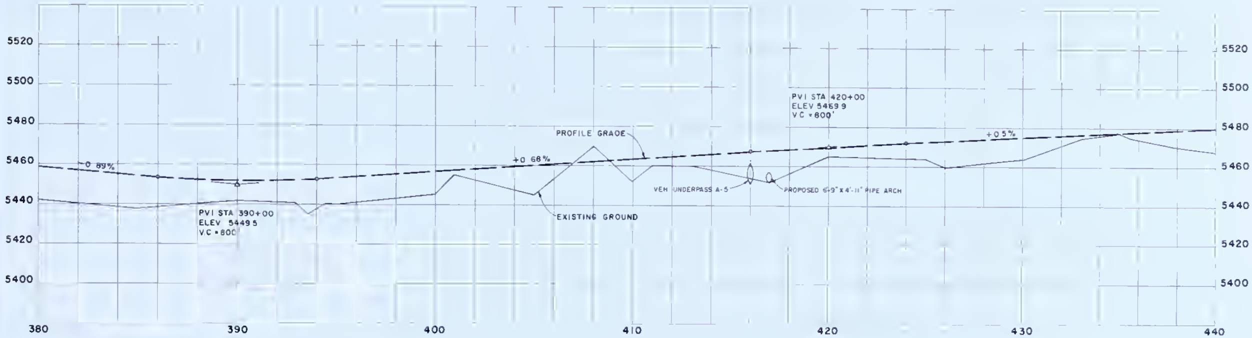
STATE HIGHWAY COMMISSION
PLAN I-15
STA. 360+00 TO STA. 420+00



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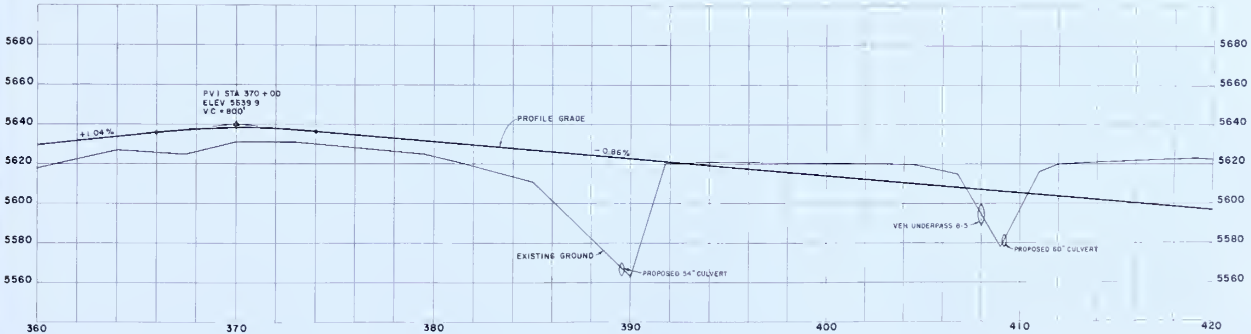

HILL ROUTE

GRAPHIC SCALE

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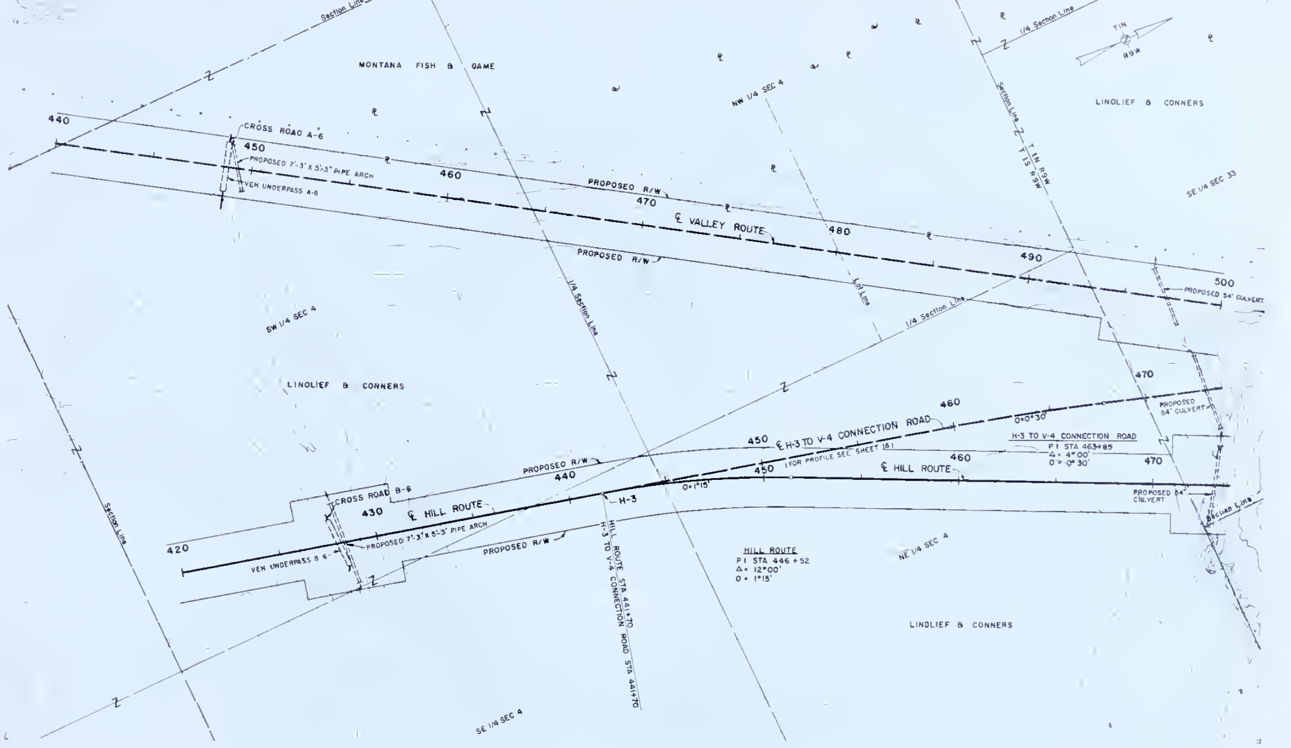
STATE HIGHWAY COMMISSION
PROFILE I-15
STA. 360+00 TO STA 420+00

SHEET 16



GRAPHIC SCALE

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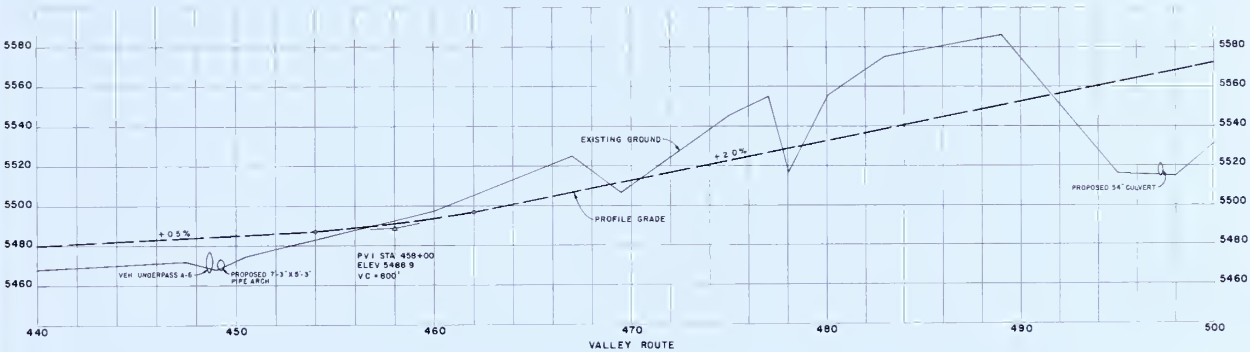
PLAN I-15
STA. 420+00 TO STA. 474+00



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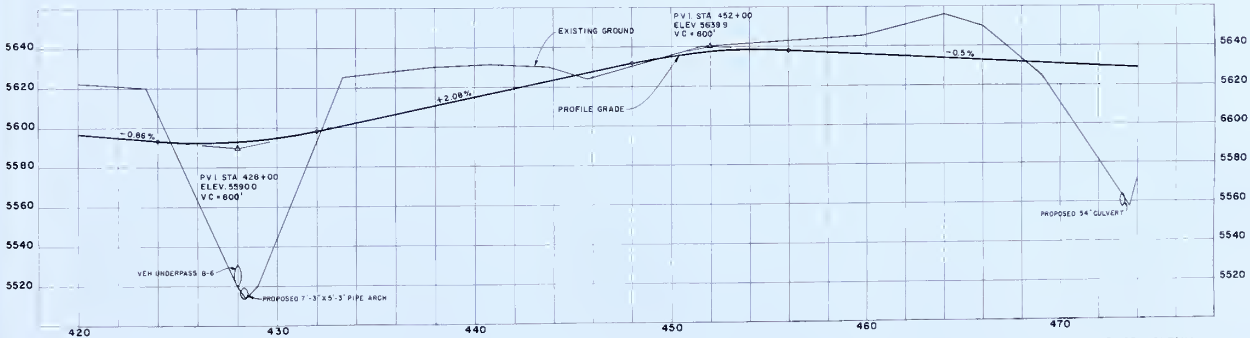

HILL ROUTE

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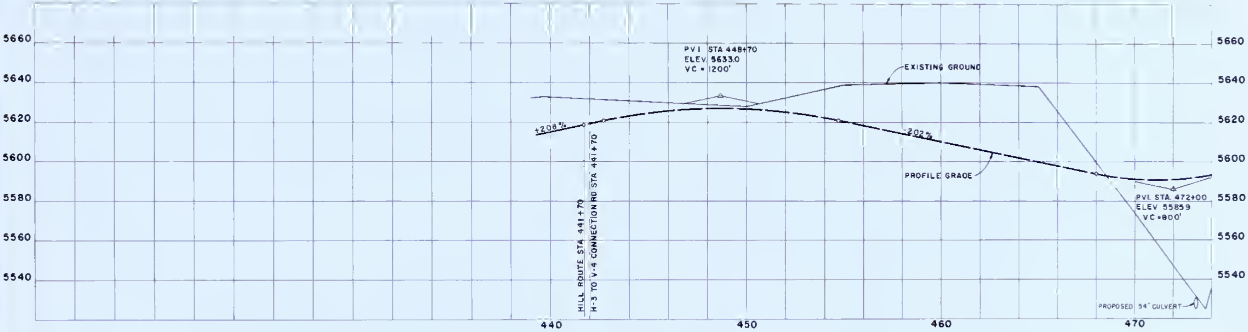
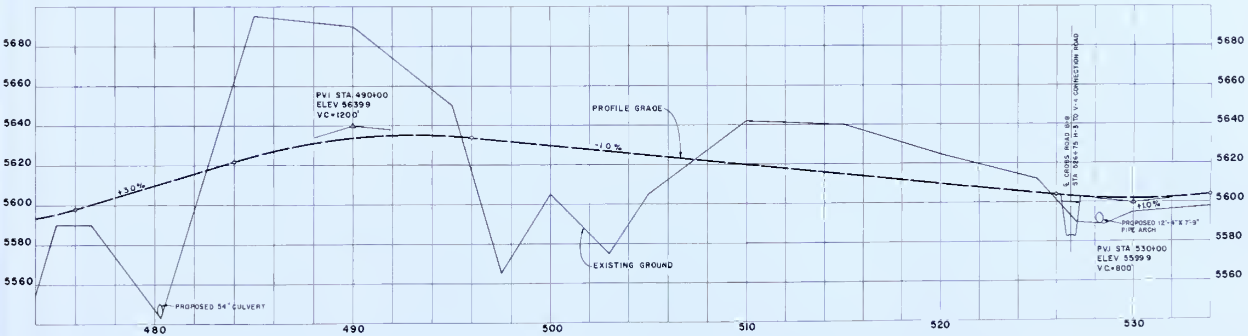
STATE HIGHWAY COMMISSION
PROFILE I-15
STA. 420+00 TO STA. 474+00





GRAPHIC SCALE

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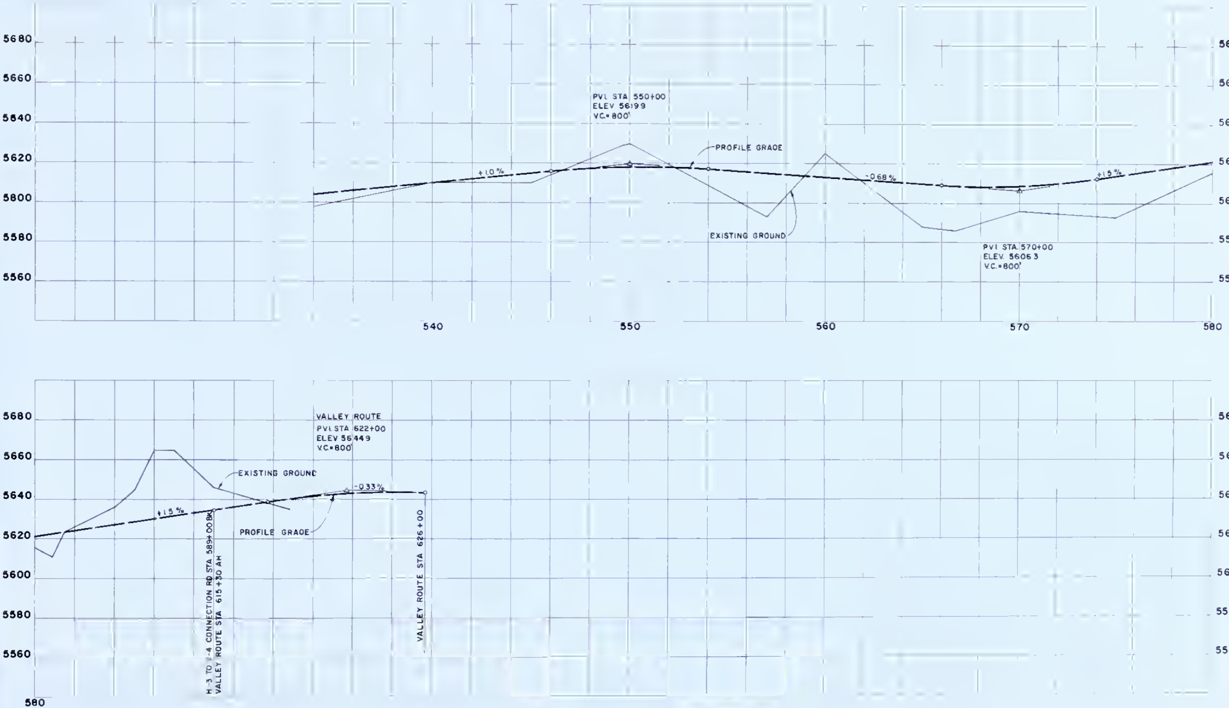
STATE OF MONTANA
STATE HIGHWAY COMMISSION
PROFILE H-3 TO V-4 CONNECTION ROAD
STA. 441+70 TO STA. 534+00



GRAPHIC SCALE
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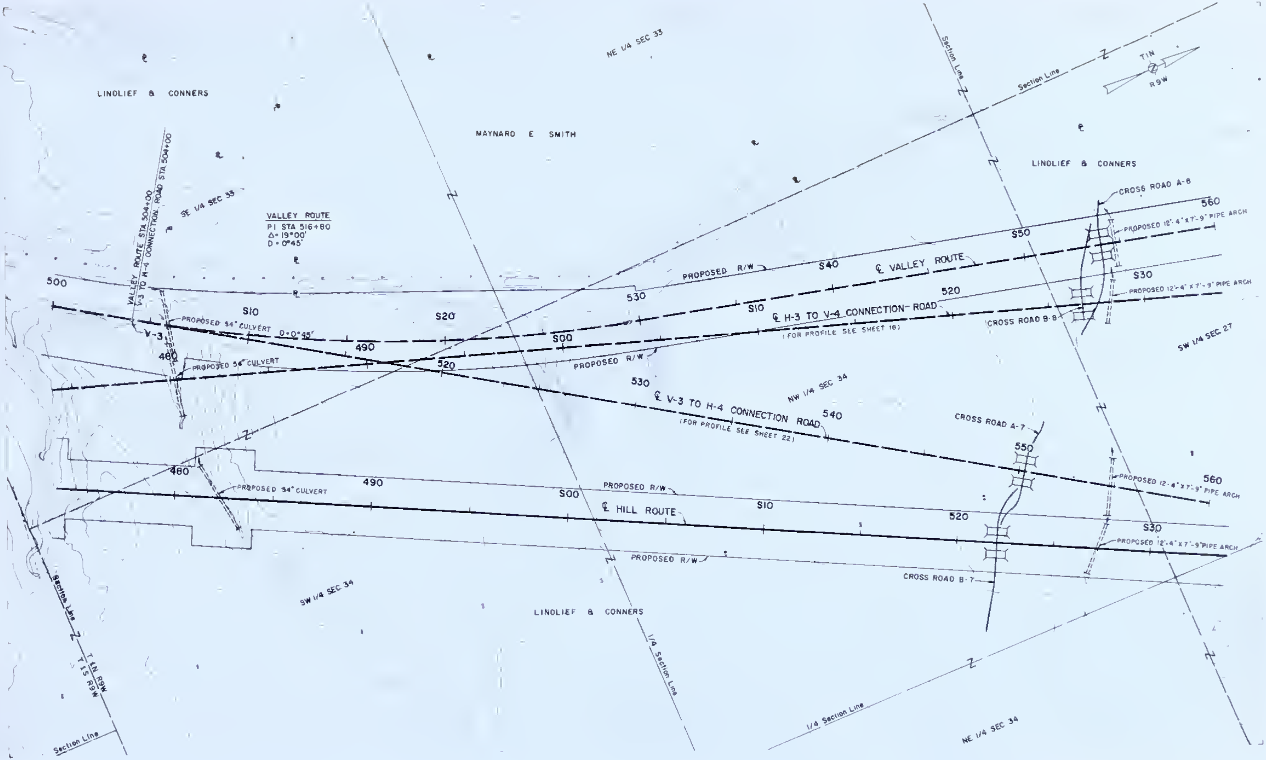
STATE OF MONTANA
STATE HIGHWAY COMMISSION
PROFILE H-3 TO V-4 CONNECTION ROAD
STA. 534+00 TO STA. 589+00



GRAPHIC SCALE

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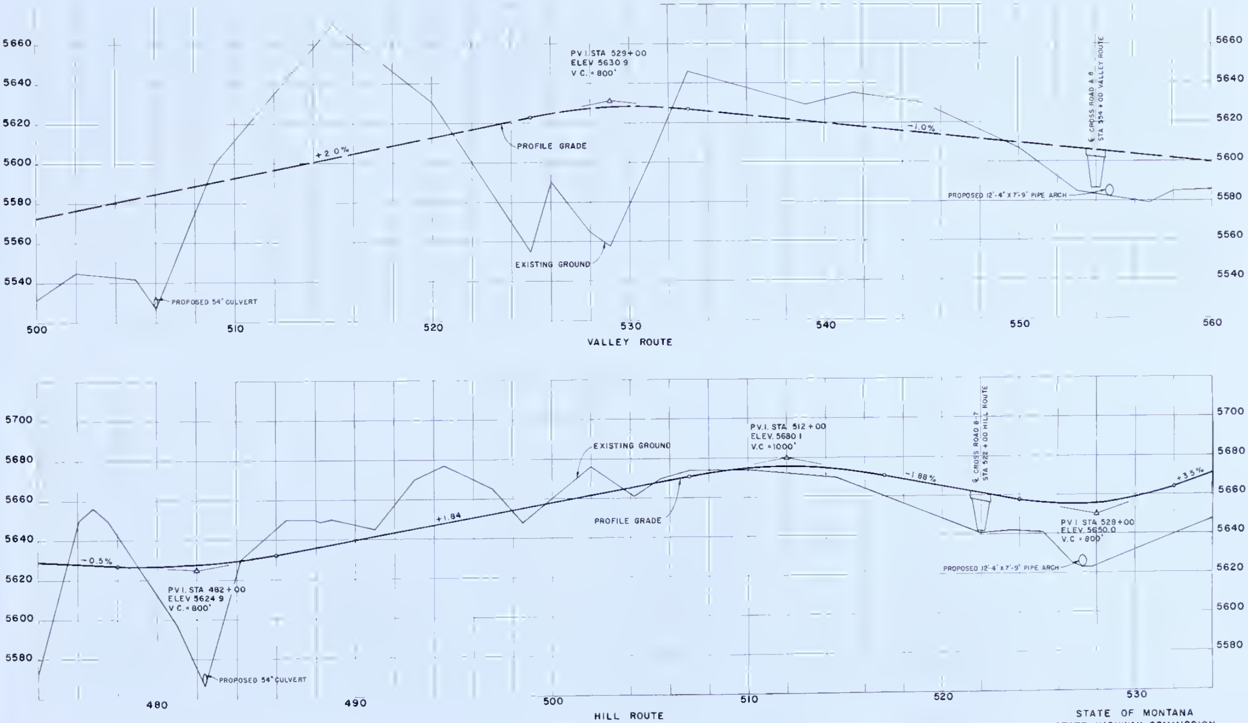
STATE OF MONTANA
STATE HIGHWAY COMMISSION
PLAN I-15
STA. 474+00 TO STA. 534+00



GRAPHIC SCALE
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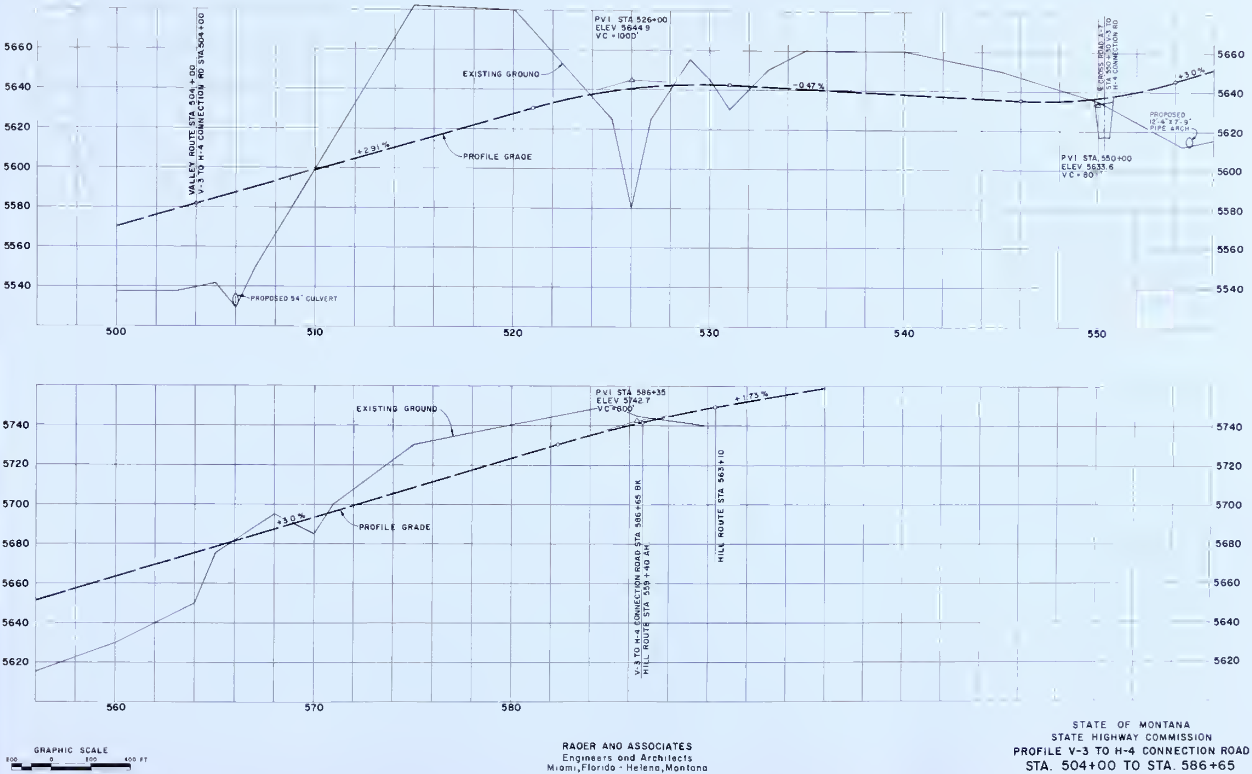
STATE OF MONTANA
STATE HIGHWAY COMMISSION
PROFILE I-15
STA. 474+00 TO STA. 534+00



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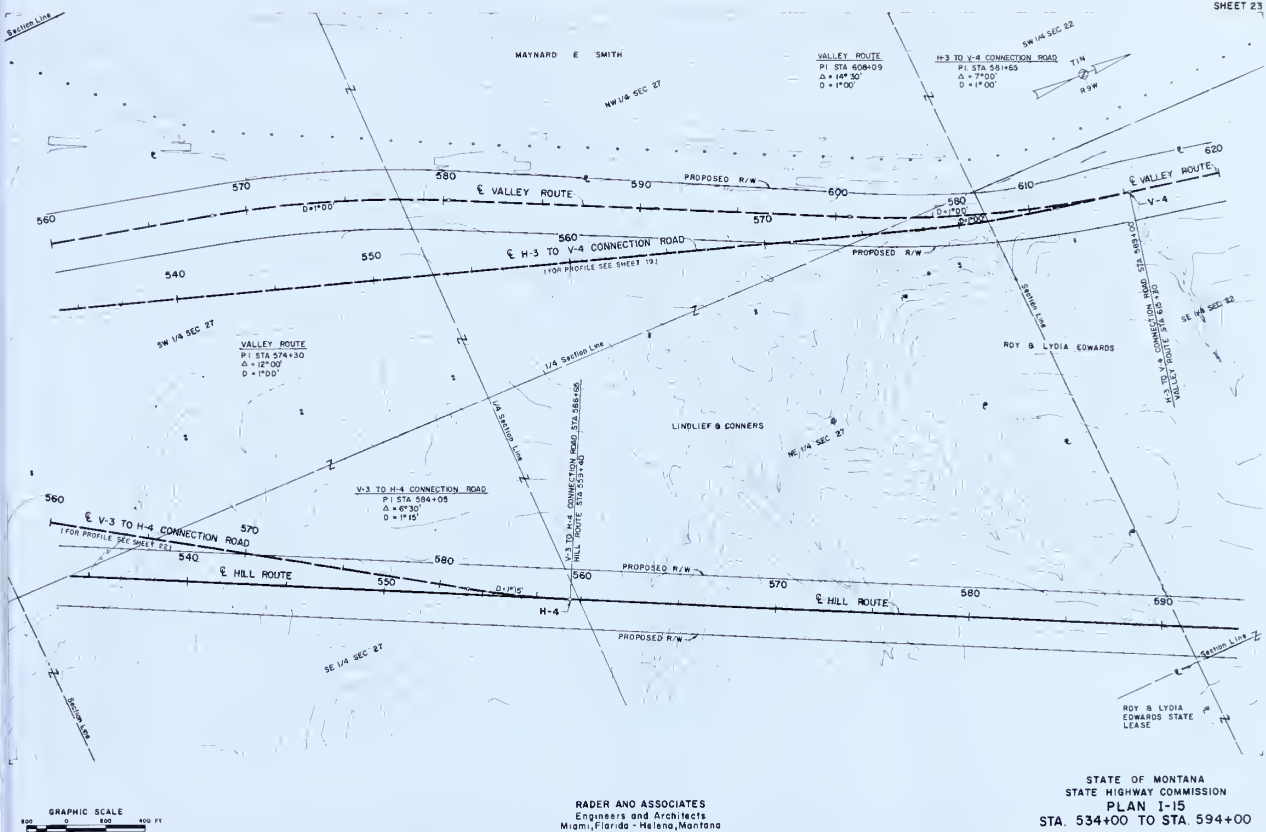
STATE OF MONTANA
STATE HIGHWAY COMMISSION
PROFILE V-3 TO H-4 CONNECTION ROAD
STA. 504+00 TO STA. 586+65



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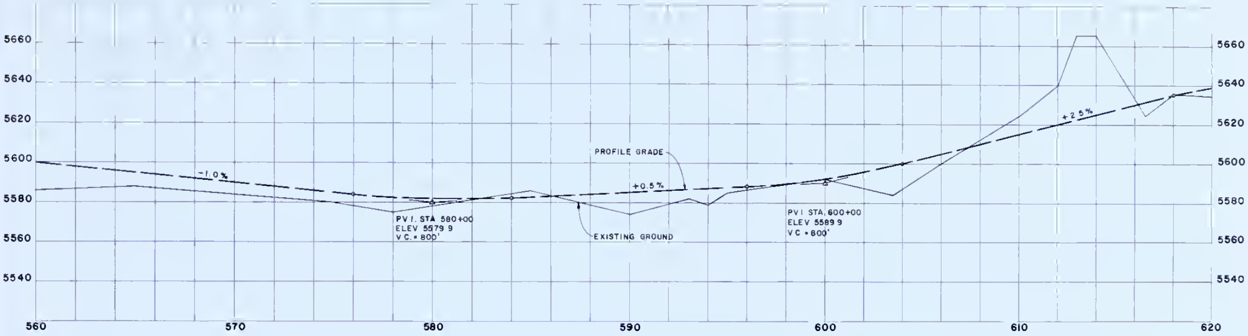
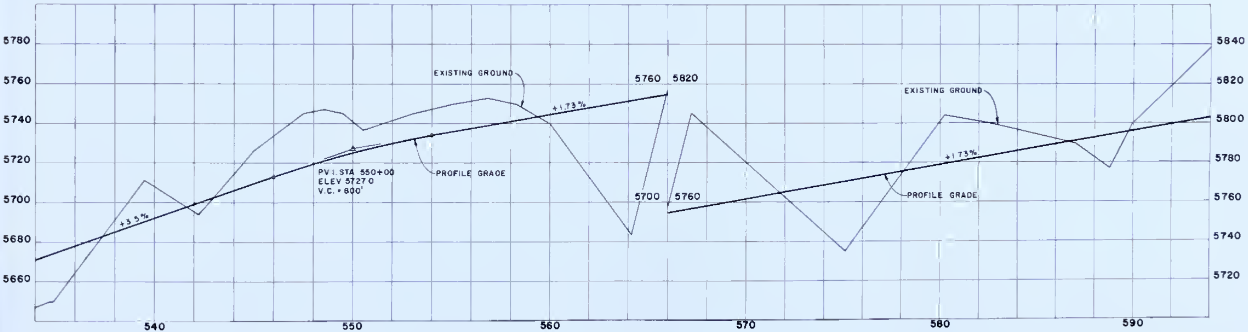
STATE OF MONTANA
STATE HIGHWAY COMMISSION
PLAN I-15
STA. 534+00 TO STA. 594+00



VALLEY ROUTE



HILL ROUTE

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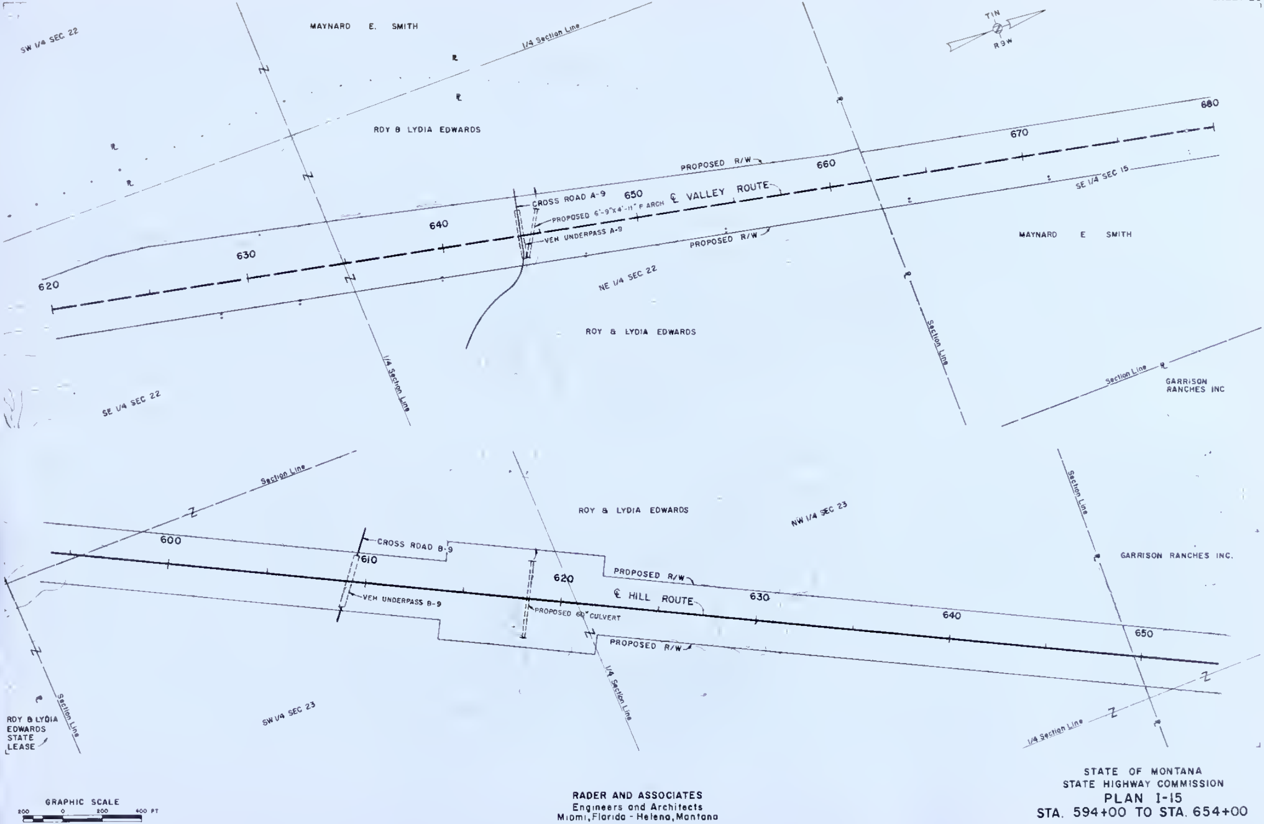
STATE OF MONTANA
STATE HIGHWAY COMMISSION
PROFILE I-15
STA. 534+00 TO STA. 594+00



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STATE OF MONTANA
STATE HIGHWAY COMMISSION
PLAN I-15
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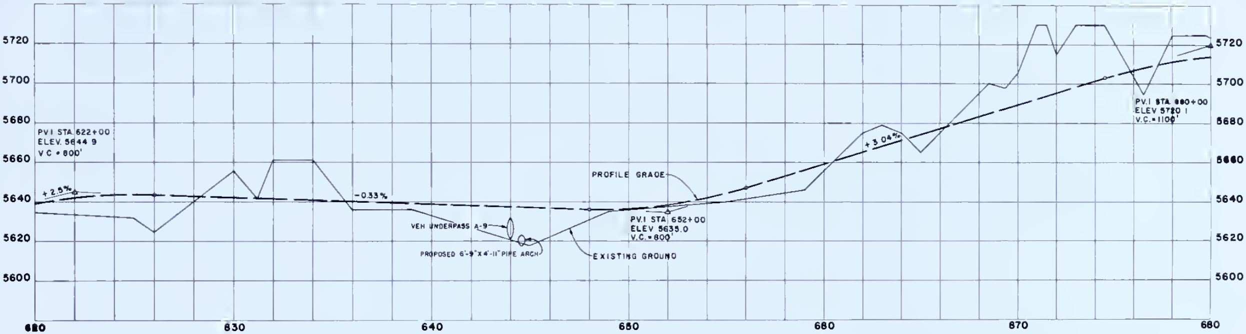

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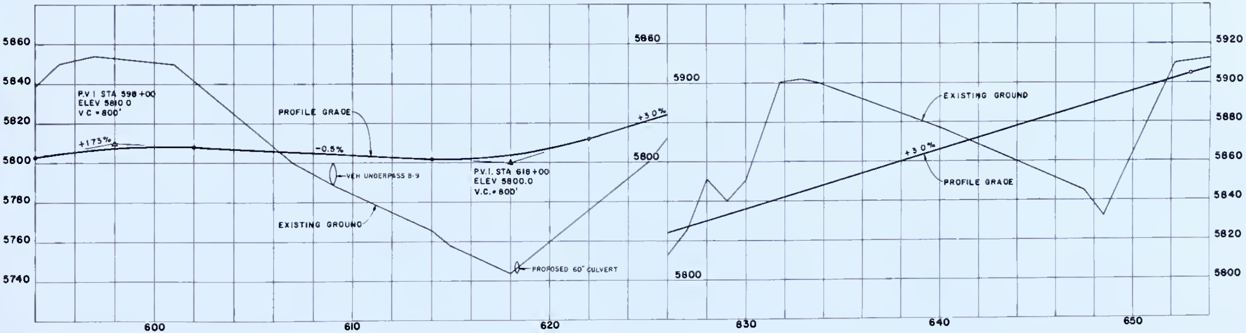

HILL ROUTE

GRAPHIC SCALE

200 0 200 400 FT

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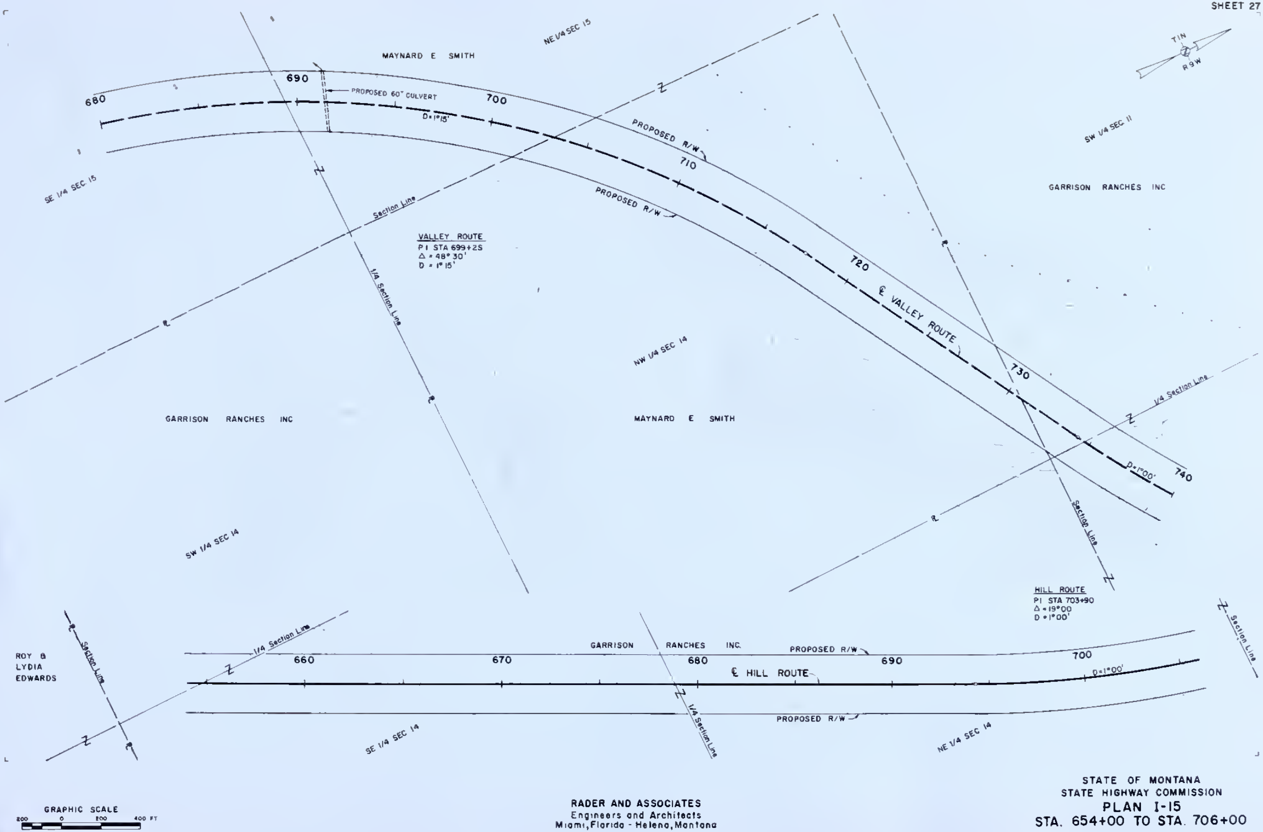
STATE OF MONTANA
STATE HIGHWAY COMMISSION
PROFILE I-15
STA. 594+00 TO STA. 654+00



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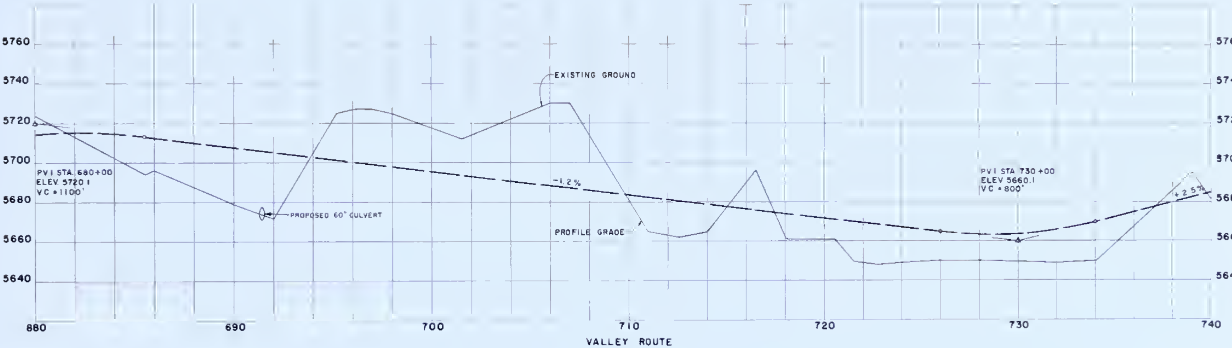
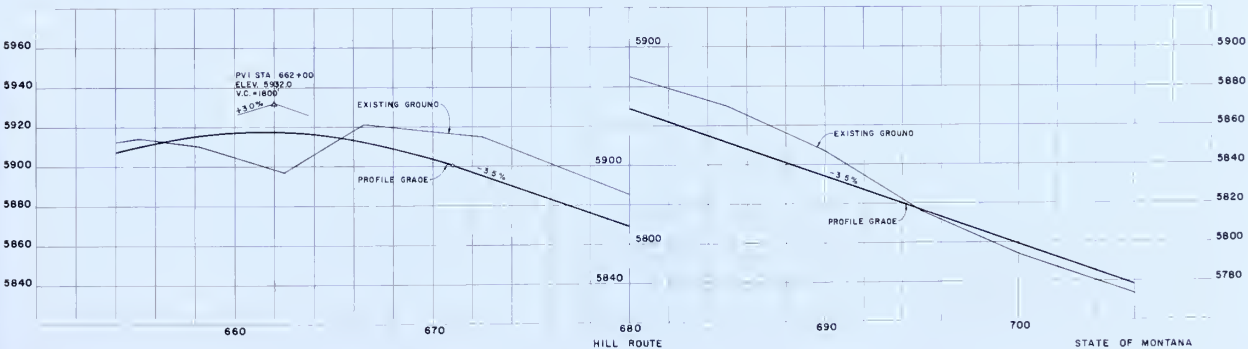
Engineers and Architects
Miami, Florida - Helena, Montana

STATE OF MONTANA
STATE HIGHWAY COMMISSION
PLAN I-15
STA. 654+00 TO STA. 706+00





GRAPHIC SCALE

200 0 200 400 FT

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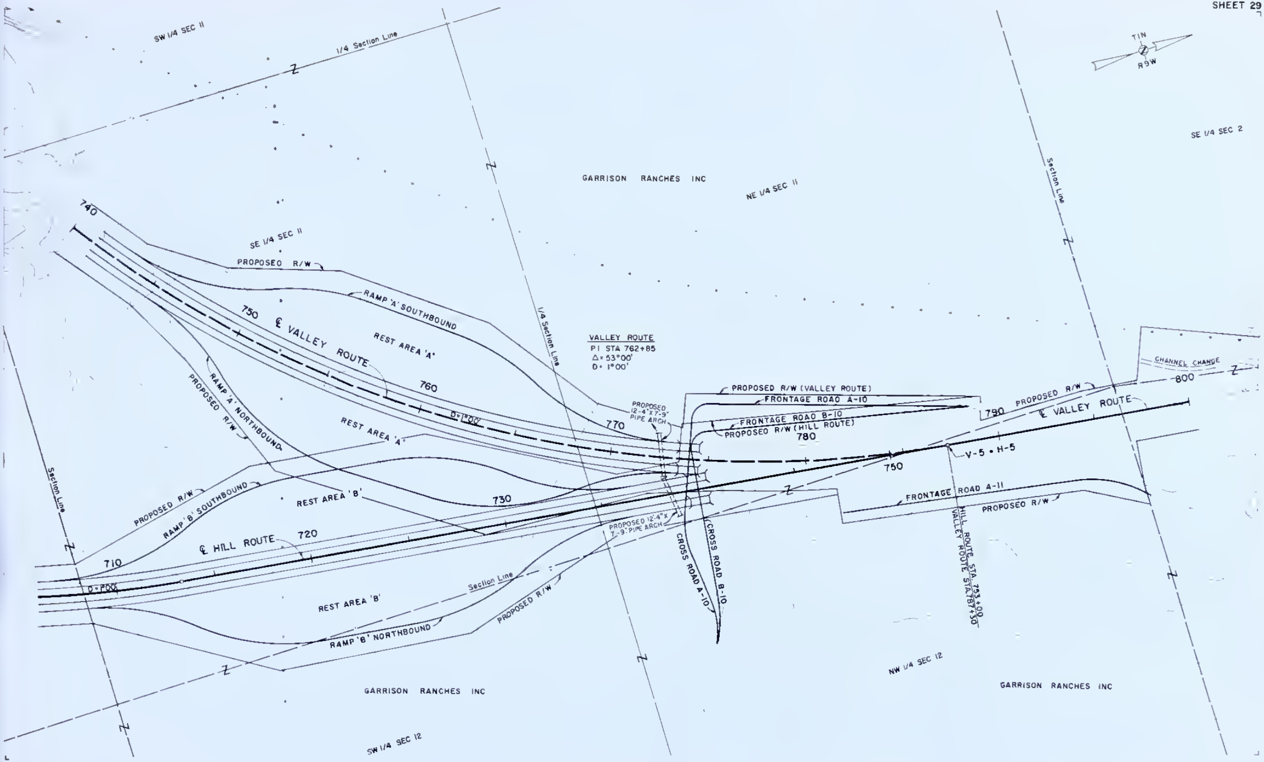
STATE OF MONTANA
STATE HIGHWAY COMMISSION
PROFILE I-15
STA. 654+00 TO STA 706+00



GRAPHIC SCALE

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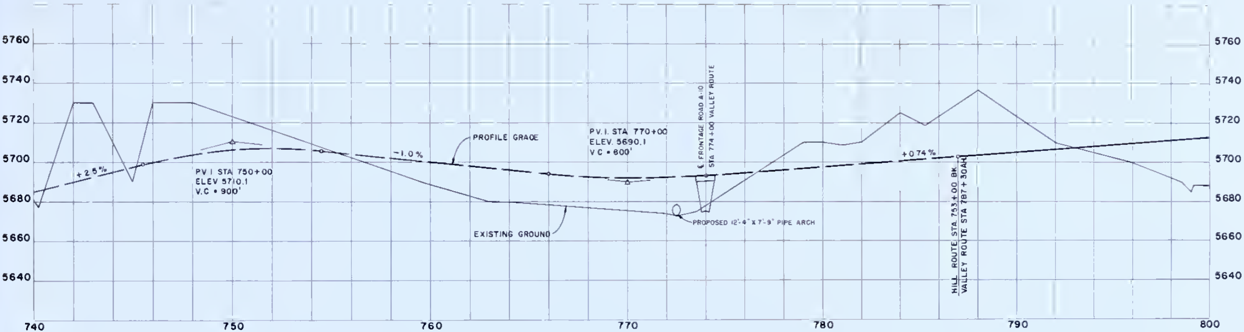
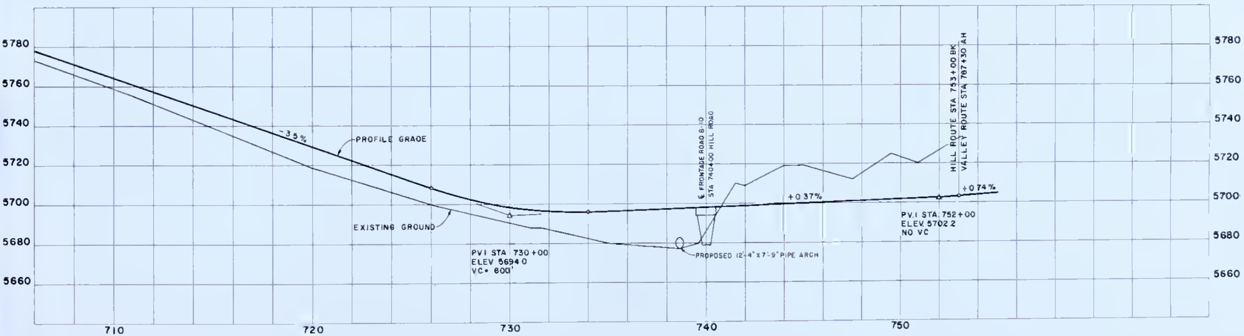
STATE OF MONTANA
STATE HIGHWAY COMMISSION
PLAN I-15
STA. 706+00 TO STA. 800+00

SHEET 30



VALLEY ROUTE



HILL ROUTE

GRAPHIC SCALE
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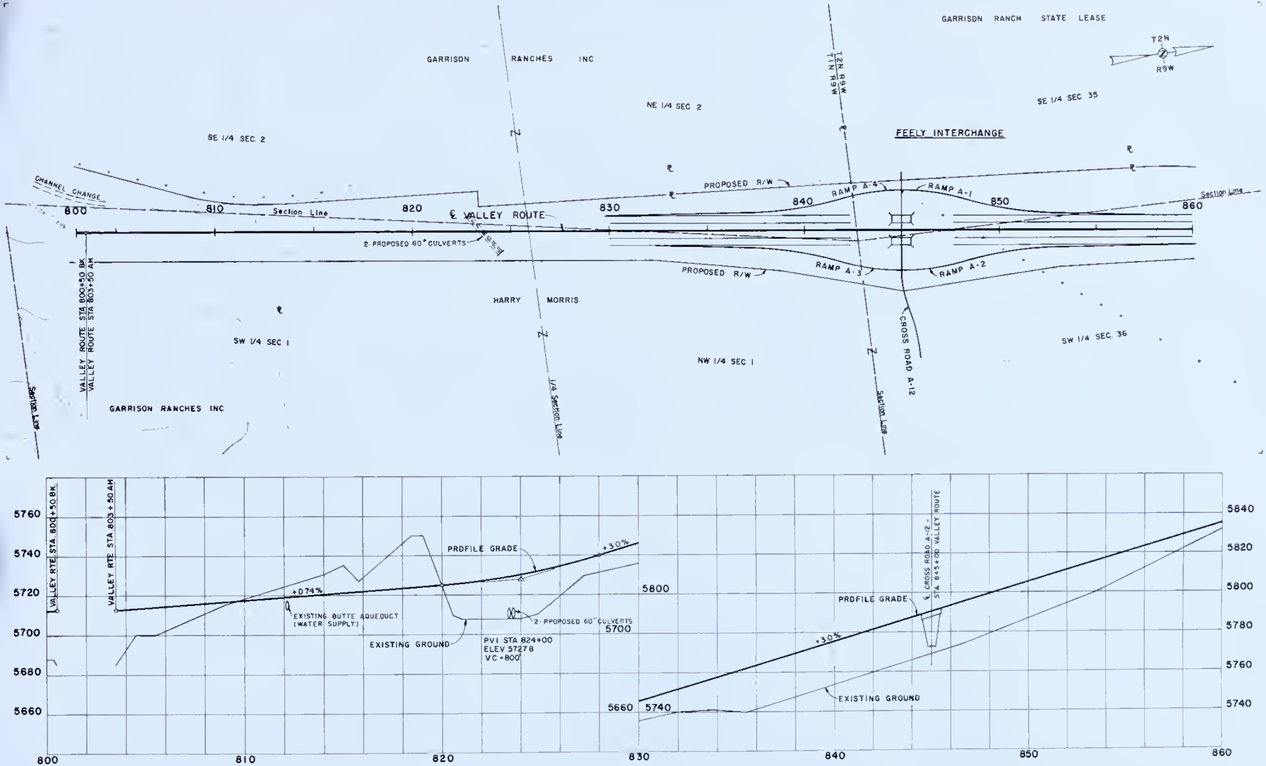
STATE OF MONTANA
STATE HIGHWAY COMMISSION
PROFILE I-15
STA. 706+00 TO STA. 800+00



VALLEY ROUTE

GRAPHIC SCALE
200 0 200 400 FT

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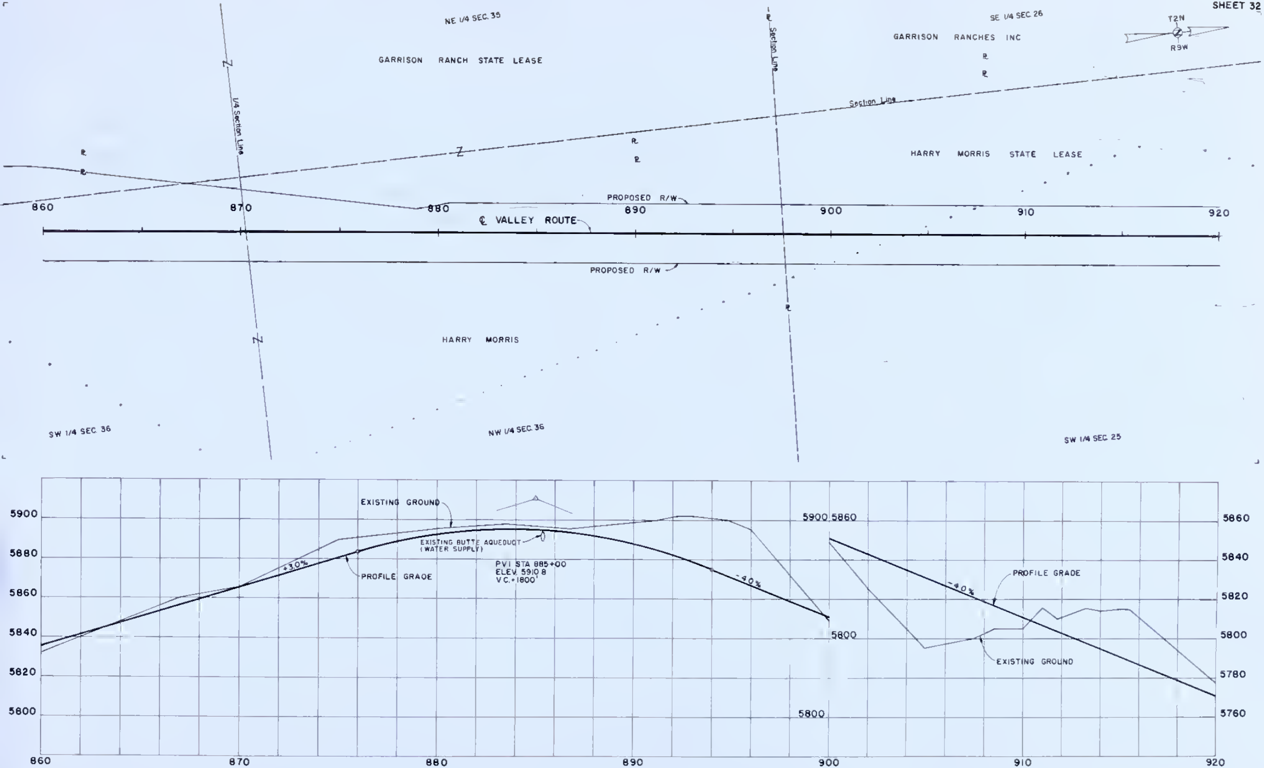
STATE OF MONTANA
STATE HIGHWAY COMMISSION
PLAN AND PROFILE I-15
STA. 800+00 TO STA. 860+00



VALLEY ROUTE

GRAPHIC SCALE

200 0 200 400 FT

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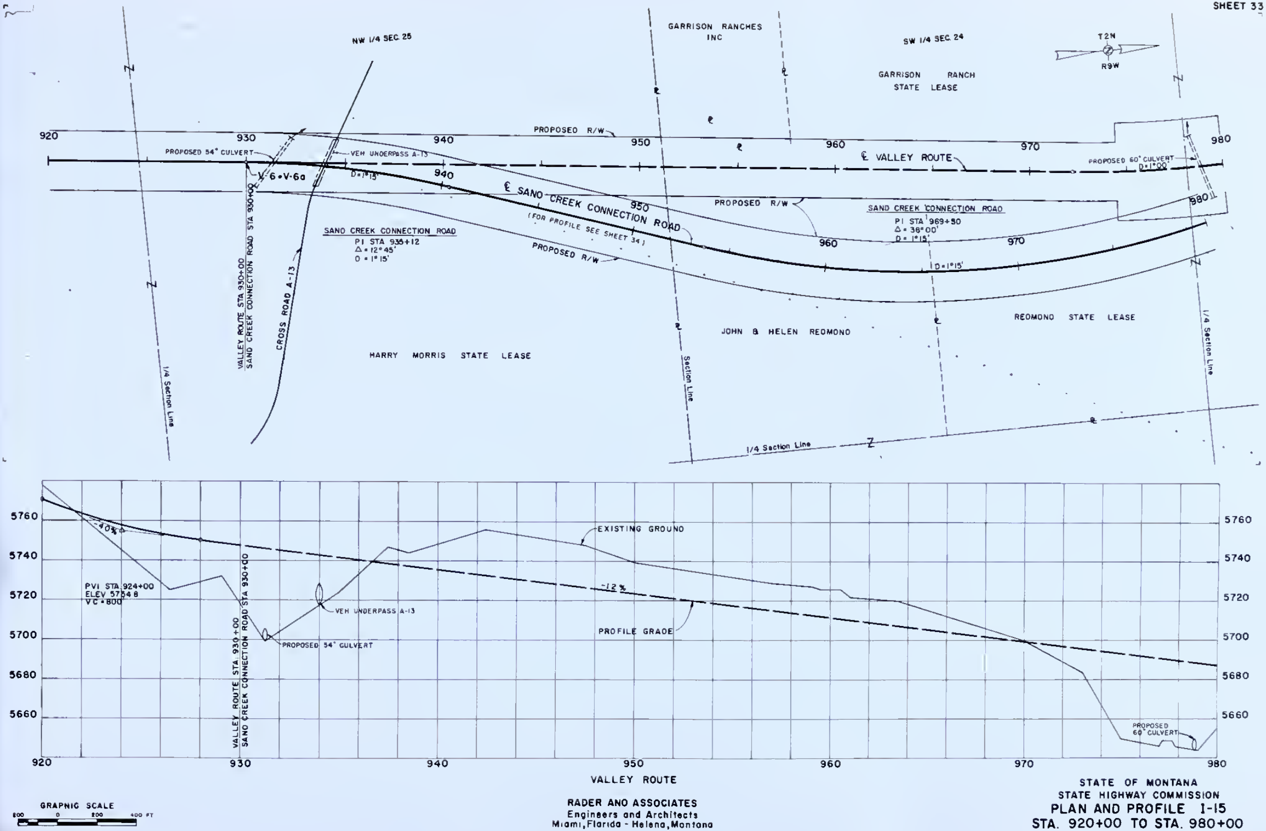
STATE OF MONTANA
STATE HIGHWAY COMMISSION
PLAN AND PROFILE I-15
STA. 860+00 TO STA. 920+00



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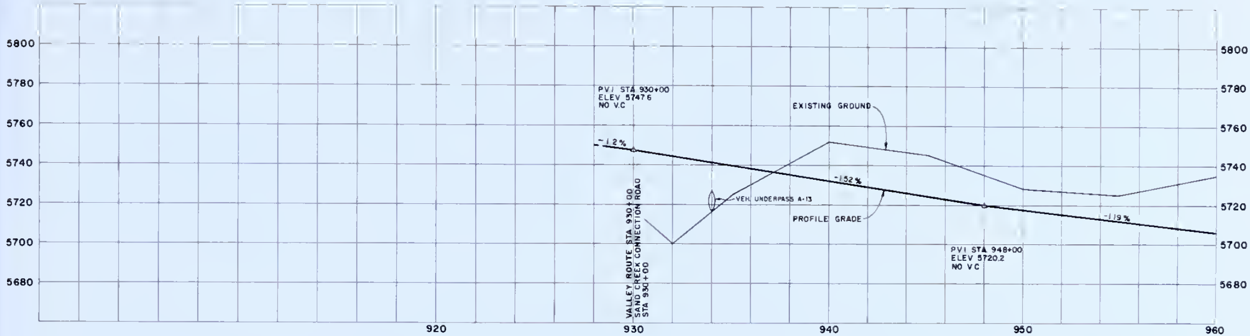
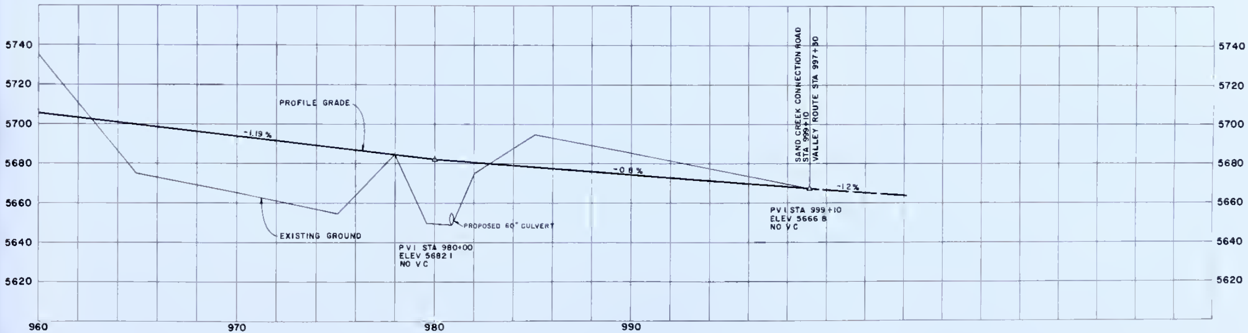
STATE OF MONTANA
STATE HIGHWAY COMMISSION
PLAN AND PROFILE I-15
STA. 920+00 TO STA. 980+00





GRAPHIC SCALE
200 0 200 400 FT

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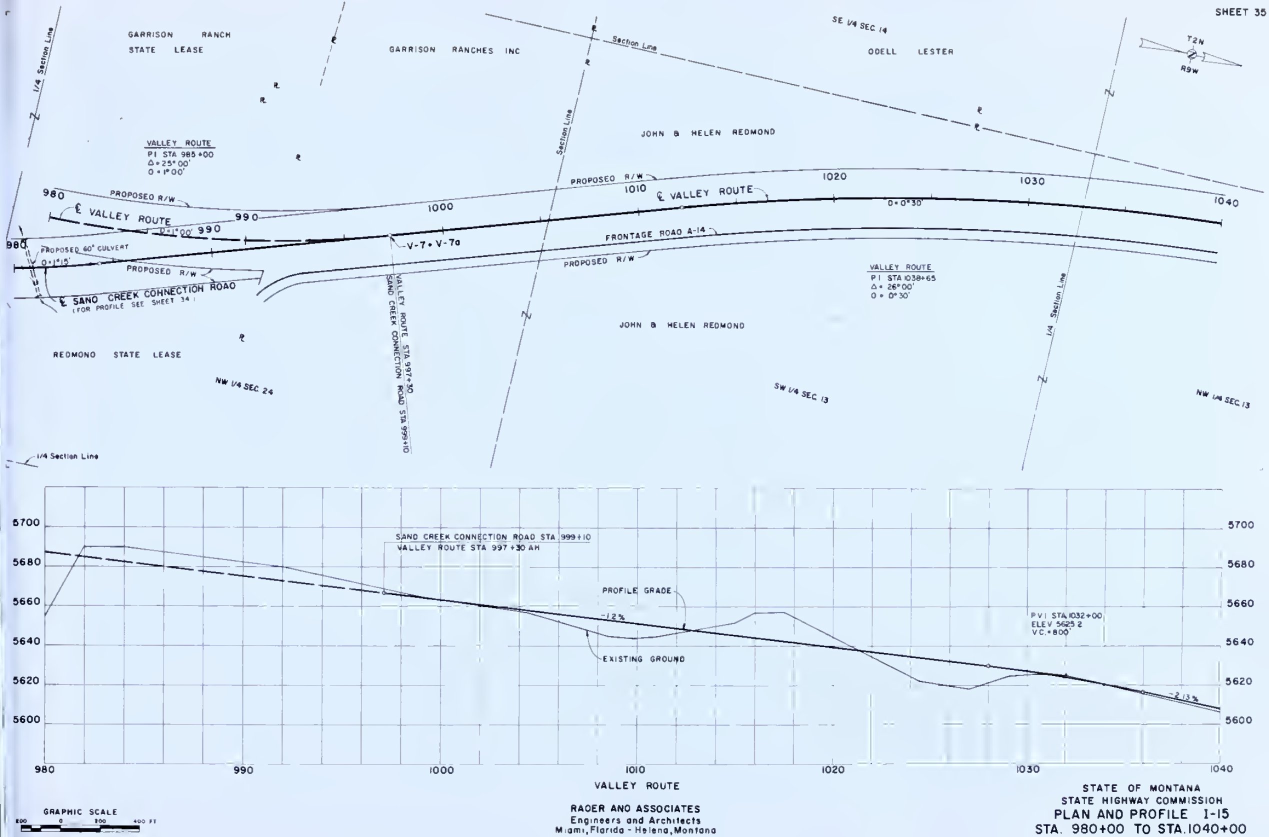
Miami, Florida - Helena, Montana

STATE OF MONTANA
STATE HIGHWAY COMMISSION
PROFILE SAND CREEK CONNECTION ROAD
STA. 930+00 TO STA. 999+10



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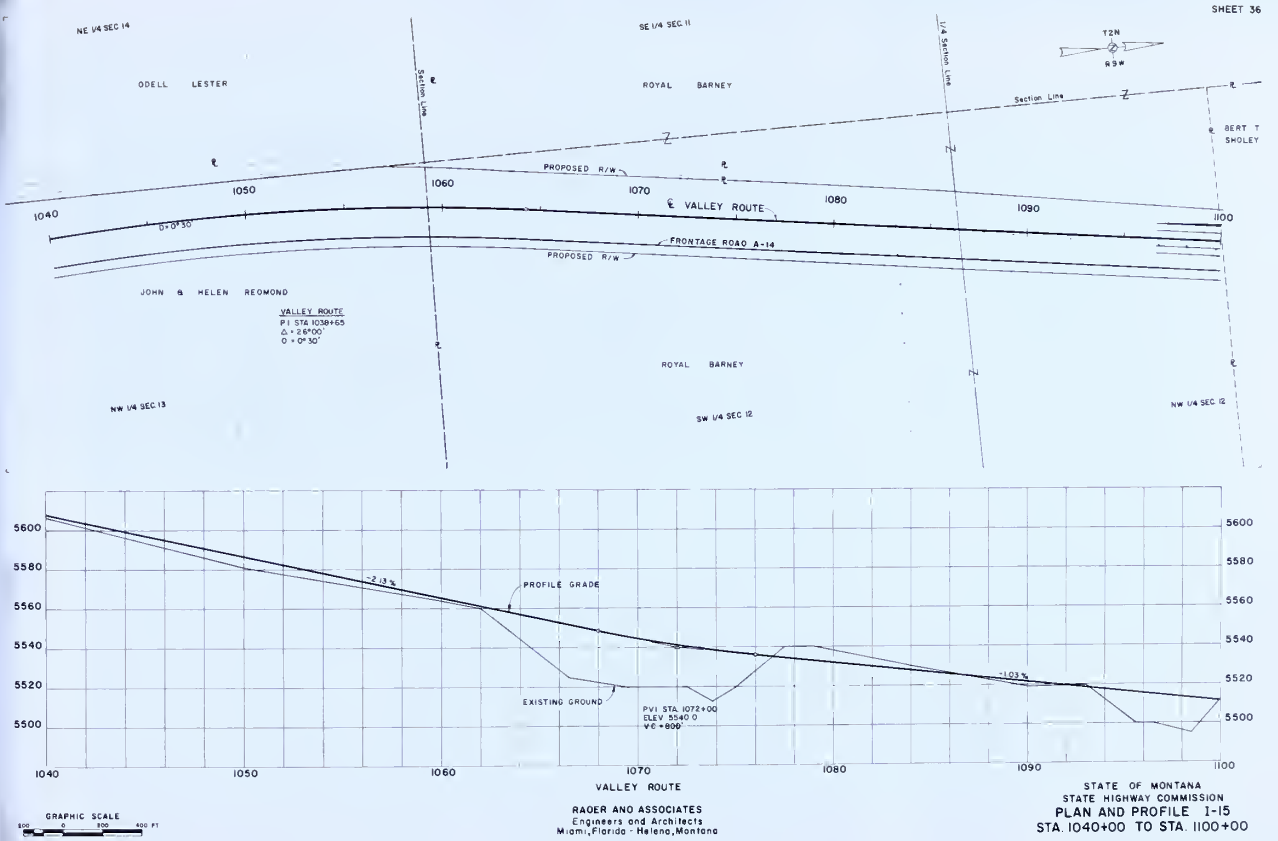
STATE OF MONTANA
STATE HIGHWAY COMMISSION
PLAN AND PROFILE I-15
STA. 980+00 TO STA. 1040+00


SHEET 36
NE 1/4 SEC 14
SE 1/4 SEC 11
T2N
R9W
ODELL LESTER
ROYAL BARNEY
Section Line
1/4 Section Line
BERT T SHOLEY
PROPOSED R/W
1040
1050
1060
1070
1080
1090
1100
℄ VALLEY ROUTE
D=0°30'
FRONTAGE ROAD A-14
PROPOSED R/W
JOHN & HELEN REDMOND
VALLEY ROUTE
PI STA 1038+65
Δ = 26°00'
D = 0°30'
ROYAL BARNEY
NW 1/4 SEC 13
SW 1/4 SEC 12
NW 1/4 SEC 12
5600
5580
5560
5540
5520
5500
-2.13 %
PROFILE GRADE
EXISTING GROUND
PVI STA 1072+00
ELEV 5540.0
VC = 800'
-1.03 %
VALLEY ROUTE
GRAPHIC SCALE
200 0 200 400 FT
RADER AND ASSOCIATES
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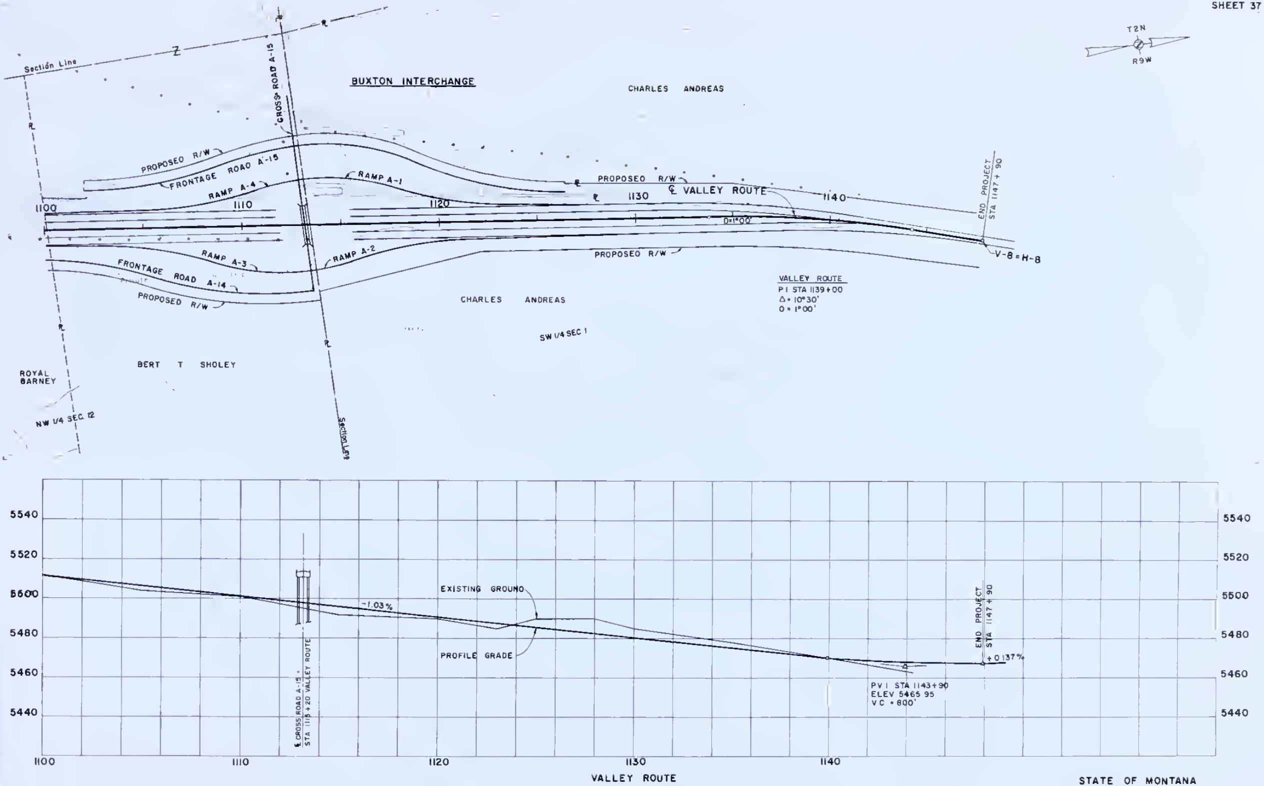
Miami, Florida - Helena, Montana
STATE OF MONTANA
STATE HIGHWAY COMMISSION
PLAN AND PROFILE I-15
STA. 1040+00 TO STA. 1100+00



GRAPHIC SCALE

200 0 200 400 FT

RADER AND ASSOCIATES
Engineers and Architects
Miami, Florida - Helena, Montana

STATE OF MONTANA
STATE HIGHWAY COMMISSION
PLAN AND PROFILE I-15
STA. 1100+00 TO STA. 1147+90